Individual Differences in Adaptability to Shiftwork: An Exploration of Models of Shiftwork Tolerance

Joanne Hill B.Sc. (Hons)

Submitted to the University of Wales in fulfilment of the requirements for the Degree of Doctor of Philosophy

University of Wales Swansea
2002

The following figures have been redacted at the request of the university:

Fig 4.1 page 114

Fig 4.2 page 115

Fig 4.3 page 116

Fig 4.4 page 117

Fig 4.5 page 118

Fig 4.6 page 120

Fig 4.7 page 121

Fig 4.8 page 122

Fig 4.9 page 124

Fig 4.10 page 125

DECLARATION

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed (candidate)

Date 01/10/02

STATEMENT 1

This thesis is the result of my own investigations, except where otherwise stated.

Other sources are acknowledged by footnotes giving explicit references. A bibliography is appended.

Signed (candidate)

Date 01/10/02

STATEMENT 2

I hereby consent for my thesis, if accepted, to be available for photocopying and for inter-library loan, and for the title and summary to be made available to outside organisations.

Signed (candidate)

Date 01/10/02

ACKNOWLEDGEMENTS

I gratefully acknowledge the financial support of Hewlett-Packard. The original intention of the research had been to conduct all stages at the site in order to contribute to the development of a Wellness Programme, designed to identify and address shiftworkers' problems. However, circumstances beyond their control a year into the project meant that this became impossible to carry to its full potential. They nevertheless continued to fund the research. I would especially like to thank Ian Pattenden for his help and support during this time.

Sincere thanks to my supervisor Simon Folkard, for his wisdom, encouragement, patience, guidance and constructive criticism. For letting me work independently and giving me the confidence to find my own way. I wish him great happiness and contentment in his retirement.

I am also very grateful to Siné McDougall for her invaluable statistics advice and consistent optimism. For always having the time to listen and making the time to help. She doesn't realise what a difference she makes.

I would also like to give my sincere gratitude to all those individual shiftworkers and organisations who so willingly gave their time and without whose help none of this would have been possible. Thanks go to all those who made this personal and invaluable contribution, for having added to the ongoing pursuit of understanding both the positive and negative aspects of shiftwork and for having passed this information on for the benefit of others.

To my family, for never asking when I would finish but always believing I would. Their faith in me has been a valuable driving force in my desire to work to the best of my ability and to pursue this to the end.

And finally, thanks to Paul for believing in me and being there every step of the way. You've been everything you needed to be and much more besides, and I dedicate this thesis to you.

ABSTRACT

In order to refine models of shiftwork tolerance, the purported relationships between outcomes and modifiers of the adaptation process were explored. A series of empirical studies amongst shiftworkers, across a variety of work patterns and industries, examined the efficacy of demographic, circadian, personality and work-related variables as predictors of shiftwork tolerance. Trends were shown to be attenuated by shift type, industry type and length of exposure to the shift system.

Using a phenomenological approach, Study 1 conducted a series of semi-structured interviews, investigating the aetiology and management of effects through the eyes of shiftworkers themselves. Analysis of recurrent themes supported established trends in the literature and showed some fit with a number of models, highlighting both outcome, and to a lesser extent, modifier variables. New relationships were also identified. Study 2 used this information to design a questionnaire for the collection of more objective data from the same site. Outcomes were capable of being meaningfully reduced into major problem domains. The number and predictive validity of modifiers varied according to the outcome under investigation, with similarities emerging between outcomes that correlated strongly with one another. Using the same approach, Study 3 examined the effect of the type of shift worked. Extent of problems and patterns of prediction showed a strong shift-dependent effect, with reliable trends emerging between those groups involved in nightwork and those not. Study's 4 and 5 explored the effect of short- (5 weeks) and long-term (12 months) exposure. Longer exposure benefited certain attitude measures and enabled better adjustment of psychological health and sleep quality. Social and domestic disruption and physical health were affected to a similar degree in both studies and therefore, did not benefit from greater exposure. Despite predictive relationships being stronger at follow-up, they were inconsistent over time, suggesting that such interactions are an evolving process.

Regardless of the shift type, industry type or length of exposure, attitudes toward shiftwork were most strongly predicted by work-related modifiers, health outcomes by circadian/personality modifiers, and sleep duration by demographic modifiers, suggesting that specific domains are differentially mediated.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1

AIMS AND RESEARCH STRATEGY

1.1. Introduction

According to Freud (1930), work is a person's strongest tie to reality, in that it provides links with the environment that prevent us from becoming overwhelmed by fantasy and emotion. However when vocations are demanding, health and well-being can be compromised. Work scheduling holds a prominent position in organisational research and practise, where shiftwork has been identified as a significant occupational stressor capable of having marked effects on a wide range of areas from sleep, fatigue and safety, to psychological and physical health, and disruption to family and social activities. As early as 1713, the Italian physician Bernardino Ramazzine recognised the potential harmfulness of shiftwork in one of the first comprehensive publications on occupational health. Discussing the plight of bakers, he stated that those who "work at night, so when others sleep they stay awake, while trying to sleep during the day like animals who escape the light; hence, in the same town, there are men living an antithetic life in comparison with others" (In *De Morbis Aritificum Diatriba* (Treatise on Diseases of Workers), cited in Costa, 1996). Despite such early recognition, shiftwork in its contemporary forms is a relatively recent addition to more modern manuals of occupational health (Costa, Folkard, and Harrington, 2000 In *Hunter's diseases of occupations*). Recent research has also seen a change of emphasis. Whilst early work concentrated on identifying the main effects of 24h operations, in the last two decades the impetus is very much on the need to find both the optimal shift system and the ideal shiftworker.

1.2. What is Shiftwork?

Shiftwork can, and has been, defined in a myriad ways (Carter and Corlett, 1981; Monk, 1988; Scott and Landau, 1990; Monk and Folkard, 1992), and is indicative of the huge variety of work patterns encompassed by the term. In its most simple form, shiftwork can be broadly defined as work that takes place either permanently or frequently outside normal daytime working hours, or where the manning of a workplace is achieved by two or more teams of employees working at different times of the day. Thus the total time covered can be either continuous for 24h or discontinuous for less than 24h a day (Kogi, 1985). At a more specific level, Van Limbourgh (1995) posits that a shift system can be understood as a complex 'vignette' in which combinations of various characteristics can be represented. These include start and finish times, duration, weekly working time, daily working time, continuous versus discontinuous, rotating versus permanent, direction of rotation, speed of rotation, distribution of free time within the cycle, number of shift changes within the cycle, and so on. The sheer breadth of different combinations of these criteria is reflected in the complexity and variety of shift systems currently in operation. Indeed, according to Knauth (1998), there are over 10,000 worktime models worldwide, although recent trends suggest that even this estimate may be conservative.

Perhaps the most inclusive definition to date is that endorsed by the European Commission who state that shiftwork is "any method of organising work in shifts whereby workers succeed each other at the same work stations according to a certain pattern, including a rotating pattern, and which may be continuous or discontinuous, entailing the need for workers to work at different times over a given period of days or weeks" (European Working Time Directive, 1998; Article 2). The present thesis also adopts this definition, since a number of work patterns, including combinations of mornings, afternoons and nights, organised in both continuous and discontinuous, and rotating and permanent, routines are investigated.

1.3. Why is Shiftwork Important?

Shiftwork is widespread in industrialised countries for economic, technological and social reasons. The economic argument posits that industrial globalisation is enhancing the drive for economic competitiveness. In response, continuous production processes and other industrial and commercial activities operating round-the-clock have become increasingly widespread. Shiftwork has long been recognised as a method of more effectively utilising fixed capital equipment, since it reduces the average amount of investment required to produce a given unit of output. In some manufacturing industries, such as the production of metals and chemicals, or in the manufacture of bricks, cement and glass (relying on kilns and furnaces), continuous operation is essential in avoiding heavy operating costs. Other than manufacturing, shiftwork is also important in public utility and service industries where a 24h service is necessary. This includes public transport, generation of power, healthcare, emergency services, security, communication and the media, to name just a few. A related and widely accepted macroeconomic advantage of shiftwork is that its adoption may reduce unemployment, since such industries rely on teams of workers to provide round-the-clock-cover.

The social argument posits that 24h services requiring work outside of the 9-5 regime gives greater opportunity for higher earnings, since abnormal hours of work are generally associated with higher income as a means compensating for the inconvenience of having to work at highly valued times of the day and week. Some figures suggest that shiftworkers earn 25% more annually than non-shiftworkers who perform the same job. According to the GMB (2002), Britain's general workers union, in 44% of collective bargaining agreements shift premiums adjust automatically with increases in basic rates of income, with double days receiving 16%, 3-

shift non continuous 22%, permanent nights 28%, and continuous shiftwork 36%. This area is discussed in greater detail in **Chapter 2**.

1.4. Prevalence

Current trends in economic growth and societal demands are key determinants in the continual rise of shiftwork amongst all occupations. Smith, Macdonald, Folkard and Tucker (1998) found a substantial increase in the proportion of the workforce involved in shiftwork over the past three decades. Estimates based on the New Earnings Survey show that in 1968 around 2 million adult workers in the UK were employed on some form of shiftwork. Today this figure has doubled to almost 4 million and covers between 13.7% (women) and 18% (men) of the working population, being most prevalent amongst emergency services, the service sector and process, plant and machine operatives, and lowest amongst managers, senior officials and professionals (Labour Force Survey, 2001). Shiftwork is so prevalent in some areas that workers accept it as a necessary part of the job. Indeed, its concentration in some of these industries in certain areas has produced communities where such work patterns are traditional and, therefore, more generally accepted. Furthermore, despite the decline of many traditional shiftworking industries, in part due to the introduction of robotics (e.g. automobile production) and sophisticated precision machinery (e.g. mining), recent figures suggest that the prevalence of shiftwork is nevertheless increasing over time. There is also evidence that the use of shifts has spread to a number of sectors not traditionally associated with work outside the 9-5, 8h day, such as computing and banking.

In modern industrialised societies, numerous and diverse systems are operated across a broad spectrum of industries, with capital intensive processes requiring more intensive shift systems to be cost effective. According to Kogi (1976) the types of work schedules employed vary considerably across different sectors and reflect, for the most part, differences in the underlying reasons for adopting shiftwork. For example, industries requiring continuous operation (e.g., the manufacture of paper and food) have a higher percentage of 3-shift workers, whilst, those adopting shiftwork for economic reasons (e.g. textiles) are dominated by 2-shift systems. In contrast, transport, communication, the media and healthcare are typically characterised by high rates of irregular night duties. Despite this, there are no recommendations for the best shift system, and some have argued that there is no single optimal system universally applicable, given the diversity of task demands across industrial settings (Knauth, 1993).

Whilst shiftwork provides round-the-clock services that most of us have now come to expect and rely on, increasing urbanisation has also affected the prevalence of shiftwork through a cycle of positive reinforcement. Increasing shiftwork to aid productivity has meant that industries not traditionally associated with shiftwork, such as entertainment, leisure and retail have also become a growing market and seen a marked increase in the number of individuals working shifts to accommodate the demand for continuous service and convenience. The recognition of availability of services has been paralleled by an increase in the shiftworking populations to traditional industries, since one can assume that individuals who would generally not choose to work 'unsocial hours' may now be encouraged to do so. Not only does it give the opportunity for shift premiums and, in some cases, a more flexible use of time, but also the ability to lead a relatively normal lifestyle.

1.5. The Changing Face of Shiftwork

Forecasts indicate that the need for shiftwork will continue to rise unabated as organisations respond to market pressures and the demand for customer convenience (Bosworth, 1994). However, if industry hopes to remain competitive and to ensure quality of services and products, whilst protecting the health and well-being of their employees, companies need to respond to the changing needs of today's workforce. Research suggests that restructuring the way that work is organised can have a positive effect on a wide range of life domains, and can improve health, reduce stress, and increase both job satisfaction and productivity. Thus the design, evaluation and implementation of shift systems are important issues in improving the day-to-day lives of the shiftworking population, as well as improving the health of the company as a whole.

During the 1990's, substantial changes occurred in international legislation on the scheduling of work hours. The European Working Time Directive (EC/104/1993) introduced specific provisions relating to the scheduling of shifts and rest breaks, annual holidays and the maximum number of work hours permissible within set periods. The legal basis for the Directive stipulates that "the Member States shall pay particular attention to encouraging improvements, especially of the working environment, as regards the safety and health of workers" (EC Treaty, Article 118A). More globally, as early as 1919, the International Labour Organisation (ILO) introduced radical new standards for the basic rights and protection of workers, focussing particularly on nightwork.

At the company level, increasing awareness has led to a number of worksite programmes aimed at promoting more flexible shift patterns. Thus a rising number of employers are acting on the desire of workers to have their patterns of work organised according to personal and social preferences. Flexible systems, such as the compressed work week or flexible work options, are seen to be one means to a happy-productive workforce, and constitute a growing percentage of the systems now in operation. Medical supervision and guidance for workers on more effective coping are also common practise, along with company-wide cultural and management issues. Indeed, all studies undertaken as part of the present thesis contributed toward the development of ongoing programmes of workplace health promotion strategies, encompassing monitoring, education, policy, workplace support and alternative forms of work scheduling.

1.6. Shiftwork Tolerance

Whatever the economic or social arguments underlying the need for shiftwork, there still exists the fact that whilst society and the demands of the industrialised world are changing, man's diurnal rhythms are not. For most of human history, man has obeyed the dictates of his biological clock, remaining active during the day and resting at night (Moore-Ede and Richardson, 1985), but with the advent of the 24h society, the pressures to push against these boundaries are increasing. There is a wealth of evidence showing that shiftwork can sometimes involve huge personal costs, resulting in a range of difficulties for those involved. These fall into three main categories: (1) the biological disruption of physiological processes, such as the sleep-wake cycle; (2) the impairment of physical and psychological well-being; and (3) interference to social and domestic roles and responsibilities. A comprehensive review of the extensive literature on shiftwork-related outcomes is presented in **Chapter 2**.

A number of authors have attempted to conceptualise the ability to adapt to shiftwork. Based on the relationship between circadian rhythmicity and subjective health, Andlauer and Reinberg (1979) coined the term 'shiftwork tolerance' and defined it as the existence of the most common health effects, including sleep-wake disturbances, digestive complaints and neurological problems. Later research has also contributed additional criteria, most notably, the wide-ranging disturbances to social life and fulfilment of familial roles. Such effects are commonly used as markers of intolerance or maladaptation to shiftwork and have become the mainstay of shiftwork research.

Whilst the concept of shiftwork tolerance can be quite simply defined, the pathogenic processes from shiftwork to impairments to health and well-being are much harder to reduce to simple statements of cause and effect. Indeed, the multifaceted nature of many of the disturbances commonly seen in shiftworkers makes it extremely difficult to pinpoint those that cause most risk and in what circumstances these risks are heightened. One prominent reason is the wealth of inter-individual differences known to affect the way in which shifts are approached, experienced and, ultimately, tolerated. According to Härmä (1993) the existence of complaints amongst shiftworkers is highly individual, a statement that has received widespread support. In his now classic, and often quoted, review Harrington (1978) concluded that "...it appears that for one reason or another 20-30% of shiftworkers do not like it, perhaps the majority tolerate it, and a few, around 10% actually like it" (pp. 15). More recent authors support the argument, with the likes of Monk *et al.*(1992) stating that any group of shiftworkers can be divided into three categories "those coping reasonably well, those who have some problems but are 'getting by' and those who are having serious problems and are barely able to cope" (pp. 45).

In the quest to identify the 'ideal' shiftworker, clinical evidence has identified a number of possible intervening or so-called 'modifier' variables, including physiological, demographic, personality and work-related factors found, at least in part, to mediate the variation in the magnitude of shiftwork-related effects. Whilst early studies tended to investigate such measures in isolation, more recent multi-trait studies have discovered that such variables are rarely mutually exclusive, but instead can work independently or in combination in producing their effects. Moreover, others have emphasised that many more influential factors have yet to be identified, and other potential candidates are yet to be investigated. It is also important to recognise that not all factors are present or even relevant in every shiftworker; some are specific to the job, whilst others depend upon the internal constitution of the individual. In contrast to our knowledge of the major problem domains associated with shiftwork, systematic research into those variables that may moderate shiftwork related problems is limited and there is still a great need to understand the evolution of these effects. Thus, a key question that remains is: Why do some shiftworkers cope better than others? A review of modifier variables is provided in **Chapter 3**.

1.7. Models of Shiftwork Tolerance

In an attempt to bring together the wealth of knowledge from the literature, and to explain the pathways from the outcomes and modifiers of shiftwork to impairments of health and well-being, a number of authors have designed models of shiftwork tolerance. The main strengths of such models lie in their ability to summarise empirical findings in a more convenient manner, thereby identifying gaps in our existing knowledge and highlighting those areas where further research is needed. In contrast, the potential of such models is undermined by the fact that the information they contain is typically hypothetical, conceptually broad and rarely based on empirical data, relying instead on assumption and theory. This is perhaps best illustrated by the fact that each model takes a different approach in modelling the manner in which elements interact, with varying emphasis (and in some cases no emphasis at all) placed on the relative impact of psychosocial, behavioural and circadian characteristics. Although more recent additions to the field are addressing these inconsistencies and have suggested that different models may be applicable to different industries and shift schedules, they nevertheless are becoming more complex as we progress from the early linear, chronobiological approaches to more multi-directional and psychological paradigms. The models posited to date, along with their evolution, are presented in **Chapter 4**.

It is undeniable that models of shiftwork tolerance provide us with the impetus and direction for future research, and for this reason alone are valuable sources of information to those who design, manage, or work, shift systems. However, the variables they contain, along with the simple and complex pathways by which they interact, need to be refined. Herein lies the aim of the present work.

1.8. Aims and Structure of the Thesis

In summary, given the continual rise in shiftwork, there is an increasing need to understand why some people tolerate irregular or abnormal hours of work better than others. Research in this area has made good progress in attempting to understand this question, and has identified a number of both outcome and modifier variables. However, for the most part, we lack an understanding of how these variables influence one another to result in the problems suffered by the shiftworking community. The existing knowledge on individual and social determinants of shiftwork tolerance is surprisingly inconclusive, due, in part, to deficiencies in the design of research and the concepts used. Most of the research in this area concentrates on single dimensions, giving little weight to how these may be strengthened or counteracted when studied in combination with one another. Whilst multi-trait studies have been conducted, they are a relatively new phenomenon. More prominently, models of shiftwork tolerance have been posited as a means of visualising the pathogenic processes from hours of work to impairments to health and well-being. These, however, typically rely on theory rather than empirical data and therefore lack the strength of evidence needed to be applied in the practical setting.

The present thesis aims to establish the validity and improve the clarity of existing models. Through a series of empirical studies of shiftworkers in a variety of industries, the efficacy of selected individual differences, including demographic, circadian, personality and work-related variables as predictors of shiftwork tolerance are examined. In doing so the studies aim to explore not just the simple linear pathways but also the multidirectional relationships between outcome and modifier variables. The relative contributions of different categories of modifiers in determining adaptation is also investigated, along with new and as yet untested variables. Shiftwork tolerance, in this sense, included measures of sleep quality and quantity, psychological and physical health, eating behaviour and diet, social and family disruption and perceived risks to safety. New concepts are also introduced. Throughout the studies, the emphasis was on gaining knowledge from the shiftworker's perspective and informed by, rather than based purely on, theory. In particular, the major aims of the studies were to:

- Investigate the relationships between outcomes;
- Investigate the relationships between modifiers;
- Investigate the effects of modifiers as predictors of shiftwork tolerance.

Chapter 5 is the first of two studies examining the aetiology and management of shiftwork related problems through the eyes of shiftworkers themselves. Using a phenomenological approach, a series of semi-structured interviews were conducted amongst a group of production line workers employed on 2-shift rotating, permanent night, and flexible working time schedules. The emphasis here was to gain qualitative data, grounded in the context of shiftworkers' experiences rather than based on theory, and to identify the most pertinent outcome and modifier variables. The key themes derived from these interviews were used to construct interaction diagrams depicting relationships between variables. **Chapter 6** forms the second part of an empirical assessment of the way in which shiftworkers experience their work. Employing a more structured and objective approach, findings from Chapter 5 were used to guide the content and design of a questionnaire. Workers at the same site completed the questionnaire in a small-scale, cross-sectional design. The major aims here were to gain more in-depth information on the most pertinent variables, in addition to validating and further exploring the findings from the interview stage in terms of the effects of shiftwork on life domains and the interactions between outcomes and modifiers.

Chapter 7 reports the results of a large-scale cross-sectional questionnaire study of maintenance engineers in a safety critical environment, employed on a variety of shift schedules (including rotating shifts with nights, rotating shifts without nights, permanent mornings and permanent nights). Analysis is performed on an existing data set that had been conducted as an audit of the range of systems used in the industry, and allowed the opportunity of validating and further exploring the relationships uncovered in the previous chapters. Given the range of shift schedules worked by this cohort, this data also allowed an investigation into whether these interactions were attenuated by the type of shift worked.

Chapters 8 and **9** examine whether tolerance to a shift was affected by the length of exposure to the present pattern of work, investigating whether interactions held over time. **Chapter 8** adopts a short-term longitudinal design. Oil refinery workers employed on permanent day shifts completed a questionnaire covering a range of measures used in previous studies during the first and final weeks of a 5-week shift cycle. Using the same approach, **Chapter 9** examines the effect of long-term exposure on the relationships between outcomes and modifiers, surveying workers on 3-shift rotating schedules at an automobile production plant. In this instance, shiftworkers completed a questionnaire 12 months apart.

Chapter 10 summarises the main findings, paying particular attention to the relationships between outcomes, relationships between modifiers and the interactions between the two. The trends found are also compared with the existing models of shiftwork tolerance. The predictive relationships between outcomes and modifiers are then discussed, and attention given to whether the relationships were attenuated by shift exposure, shift type, or the type of industry under investigation. This section also discusses the methodological limitations of the research (including the methods used and the problems of conducting research in industrialised settings). Practical applications and directions for future research based on the trends found are also detailed. This chapter ends with a discussion of the true value of models of shiftwork tolerance, considering their theoretical significance in the light of the knowledge gained here.

2

OUTCOMES OF SHIFTWORK

2.1. Introduction

Shiftwork is superimposed upon the most varied of activities and should be viewed, not simply as a work pattern, but as a lifestyle that involves the commitment of the individual in most areas of their daily lives. Man is a diurnal animal whose biological, psychological and social rhythms are temporally organised to be awake and active during the daylight hours and at rest during the night. For many, shiftwork interferes with these rhythms and results in the disruption of a wide variety of functional domains, from sleep, diet, and physical and mental well-being to social and family life, and task performance. The present chapter reviews these functional domains, which, either separately or in combination, make up what some authors have termed 'shift-lag syndrome', 'shiftwork-induced syndrome' or 'shift maladaptation syndrome' (Scott and Landou, 1990).

We begin by reviewing the evidence on the most pertinent of problems, that of sleep disruption (Section 2), paying particular attention to the distinctive patterns of disturbances and theories that have been posited as underlying mechanisms. Since reduced sleep often leads to fatigue and reduced work efficiency, which in turn has implications for the safety of workers, accident risk is discussed in Section 3. Here evidence showing circadian rhythmicity in the ability to perform different tasks during the 24h cycle is discussed. Section 4, the most extensive of the chapter, reviews the effect of shiftwork on health. Here a series of angles are taken, reviewing the effect of shiftwork on not only the more traditional outcomes of cardiovascular, gastrointestinal, and affective complaints, but also the relatively new topics of reproductive health, cancer, and immune function. Toxicological risks are also discussed. Section 5 reviews the literature on the disruption of diet and the eating behaviours that can result from working irregular hours, and discusses the major methodological weaknesses apparent in the research to date. In Section 6, the notion of social disturbance is introduced, showing how the shiftworker allots value to certain times of the day and night, the importance of social support in buffering the shiftworker from problems, and the link between an impoverished social life and impaired health. Section 7 reviews the effect of shiftwork on the domestic life of the shiftworker, paying particular attention to the ways in which shiftwork can be problematic for other members of the family. Finally, Section 8 reviews the evidence on attitudes towards shiftwork. Areas requiring more extensive research and questions that have yet to be answered are highlighted throughout the chapter.

2.2. Sleep and Fatigue

Sleep is as basic to us as food and water and the fact that we spend at least one third of our lives sleeping further underlines its importance. However, with the advent of the modern 24h society it is a need which is easily sacrificed and, according to some authors, has led to a "modern epidemic that is taking a catastrophic toll upon our bodies and minds" and a "sleep deprived society" (National Sleep Foundation (NSF), 1997). According to the NSF, in the past century we have reduced our average time asleep by 20% and in the past 25 years have added a month to our average annual work/commute time. But, although society has changed, our bodies have not. Such statistics are particularly relevant given that recent research suggests cutting back on sleep upsets the body's metabolism, hastening the onset and severity of age related ailments such as diabetes, hypertension and memory loss (Spiegel, Leproult and Van Cauter, 1999).

Unlike many of the other topics discussed within this chapter, it is universally acknowledged throughout the literature that, of all the problems associated with shiftwork, disturbance of sleep is one of the most inevitable and far reaching (Thiis-Evensen, 1958; Aanonsen, 1964) affecting most other aspects of daily life from appetite and health through to performance and the quality of time spent with family and friends. Harrington (1993) stated that "sleep loss is the major effect of shiftwork" (pp. 11), whilst Knauth *et al.* (1982) found complaints about disturbed sleep to be the most frequent made by shiftworkers. Furthermore Lavie, Chillag, Epstein, Tzinschinsky, Givon, Fuchs and Shahal (1989) showed that shiftworkers who complained of disturbed sleep were less satisfied with their work, had more domestic problems, had increased morbidity for cardiovascular complaints (such as hypertension and high diastolic blood pressure), more anxiety, took more medications and had more accidents, than workers who reported no sleep problems. From these results they argued that sleep disturbances could be used as a marker of the level of adaptation to shiftwork. In the same vein, Foret and Benoit (1980) stated that "A basic requirement for a real adaptation to shiftwork is maintaining the quantity and quality of sleep" (pp.56).

2.2.1. Sleep Strategies

According to Tepas, Walsh, and Armstrong (1981) most working days can be partitioned into three time periods: work-time, sleep-time and leisure-time, and it is the sequencing of these periods that can affect the sleep of shiftworkers. For example, nightworkers typically sleep after work and take their leisure time before their shift begins (work-sleep-leisure) (Monk, 2000), whilst those working morning shifts are similar to dayworkers in that they typically take their leisure after work, followed by their sleep (work-leisure-sleep). On the other hand, those working afternoon/evening shifts arrange their time so that leisure follows sleep and comes before work (sleep-leisure-work). On most days off, however, the majority of workers, regardless of the shift system worked, will adopt the sleep strategy of the dayworker, sleeping at night and waking during the day (Tepas and Carvalhais, 1990).

Knowledge of the sleep strategies used by shiftworkers are fundamental to our understanding of sleep problems since the organisation of work and rest time will ultimately affect the type and extent of circadian desynchronisation associated with different shift types. For example, night sleep before the first night shift is typically long, starts prematurely, is terminated at 08:00 or later (Knauth and Rutenfranz, 1981; Härmä, Knauth and Illmarinen, 1989; Rosa, 1993) and is frequently associated with napping in the afternoon (possibly for prophylactic reasons), especially if sleep had been short or disturbed. Such naps show little variation (having an SD of between 30 and 60 minutes) and are typically taken no more than one hour after the shift has finished. Furthermore, around 50% of nightworkers experience a spontaneous and effortless sleep termination (Åkerstedt, Kecklund, and Knutsson, 1991) although, according to Tepas *et al.* (1981) nightworkers are more likely to set alarms. Sleep taken between successive night shifts is also often supplemented by a mid afternoon nap in one-third of workers, lasting for over an hour (Knauth and Rutenfranz, 1981; Åkerstedt *et al.*, 1991) although the number of naps taken tends to increase as the length of the main sleep decreases (Åkerstedt and Torsvall, 1985; Rosa, 1993).

Due to the early start of the morning shift (usually around 06:00) the first night sleep is truncated because workers fail to phase advance their bedtimes appropriately (Åkerstedt *et al.*, 1991; Folkard and Barton, 1993). Sleep is usually terminated around 1h before the start of the shift. Early shifts are strongly associated with napping during the early afternoon, with around one-third taking a nap shortly after returning home from work (Knauth *et al.*, 1981; Tepas, 1982; Åkerstedt *et al.*, 1985; Härmä *et al.*, 1989). For many, this may also carry on throughout the evening. Afternoon shifts are generally no different to daywork and present fewer problems. As a result they have been paid scant attention in the literature. Since the shift start time (around 14:00) allows a more relaxed sleep regime, the pattern of sleep strategies shows a wider variation (Åkerstedt, 1998). Such workers tend go to bed between the hours of 23:00 and 01:00 and wake around 08:00, and napping is usually absent (Knauth *et al.*, 1981; Åkerstedt *et al.*, 1991).

2.2.2. Patterns of Disturbance

In the same way that the sleep strategies employed are not uniform, neither are the type or severity of sleep problems. Knauth (1983) reviewed a number of studies involving 18,352 shiftworkers and dayworkers in 11 different countries. Sleep disturbances were reported by approximately 10-40% of dayworkers, 5-30% of shiftworkers with rotating morning and afternoon shifts, 10-95% of shiftworkers with rotating shifts including nightwork, 35-55% of permanent nightworkers and 70-90% of shiftworkers who later switched to daywork. Furthermore, research into the effects of shift type on sleep has also illustrated that it affects not only the duration and quality of sleep but also the latency and temporal organisation of sleep stages, in addition to the spectral power density of electroencephalographic (EEG) sleep recordings.

Although the figures range, the general findings from the literature have shown that, in terms of duration, sleep is shortened by between 1h and 4h in connection with morning and night shifts, whilst sleep following an afternoon or day shift is relatively unaffected (Reinberg, Chaumont and Laporte, 1975; Åkerstedt and Gillberg, 1980; Åkerstedt, Gillberg and Kecklund, 1990; Kiesswetter, 1993). Moreover, sleep taken in the day is shorter than that taken at night, irrespective of whether the schedule involves rotating or permanent shifts (Aanonsen, 1976; Rutenfranz, Colquhoun, Knauth and Ghata, 1977; Åkerstedt, 1979; Åkerstedt and Gillberg, 1980, 1981; Åkerstedt and Torsvall, 1980; Knauth *et al.*, 1980; Walsh, Tepas and Moss, 1981; Armstrong, 1982; Tepas, 1982a, 1982b; Tilley, Wilkinson, Warren, Watson and Drud, 1982; Tepas, Armstrong, Carlson, Duchon, Gersten and Lezotte, 1985; Gersten, 1987; Torsvall, Åkerstedt, Gillander and Knutsson, 1989; Åkerstedt, Arnetz and Anderzén, 1990; Smith, Totterdell and Folkard, 1995; Gillberg, 1998).

This apparent shortening of sleep length in connection with night and morning shifts has been closely related to the disruption of the temporal organisation of the various sleep stages. EEG studies of sleep in shiftworkers in both laboratory (Matsumoto, 1978; Dahlgren, 1981) and field settings (Foret and Lantin, 1972; Tilley, Wilkinson and Drud, 1981; Torsvall, Åkerstedt and Gillberg, 1981; Torsvall *et al.*, 1989) have consistently shown that the shortening of day sleep is primarily attributed to a decrease in Stage 1 and Stage 2, and a decrease in latency and amount of REM sleep, (30-50% according to Åkerstedt *et al.*, 1990). Although some authors have argued that deep sleep (Stages 3 and 4) shows few changes (Knauth and Rutenfranz, 1972; Bryden and Holdstock, 1973; Foret and Benoit, 1974; Torsvall, Åkerstedt and Gillberg, 1981) both Matsumoto and Morita (1987) and Costa (1996) found that day sleep following night shifts resulted in a reduction of both. Computer analysis of the low frequency activity in polysomnographic studies, which more sensitively reflects the homeostatic processes during sleep, have supported this later view. In terms of EEG spectral power density, Åkerstedt *et al.* (1990) showed a reduction of approximately 25% within the delta-theta range (slow wave activity). Similarly, Åkerstedt *et al.* (1991) reported that in workers on night call duty the spectral power density in the 0.5-7.9Hz band was suppressed.

Some authors have argued that reduced sleep is not necessarily accompanied by a reduction in quality (Mahan, Carvalhais and Queen, 1990). However there has been some evidence to suggest that the day sleep of nightworkers is characterised by a shorter latency (defined as the time from lights out to the appearance of the first sleep stage) (Åkerstedt, 1990; Åkerstedt *et al.*, 1990; Folkard, Arendt and Clark, 1991). Kiesswetter (1993) reported that day sleep subjects fell asleep more rapidly with less wakefulness prior to Stage 1 and Stage 2, whilst the latency to Stage 3 was also reduced. Torsvall *et al.* (1989) found that sleep latency was halved in day sleepers compared to those who slept at night, although no differences in the latency to Stage 1 or REM sleep were reported. In addition nightworkers who sleep during the daytime are reported to complain of premature awakenings and feelings of obtaining too little sleep (Åkerstedt and Torsvall, 1981), whilst the evening sleep of those on the morning shift is associated with difficulties awakening and a strong feeling of insufficient recuperation (Åkerstedt and Gillberg, 1981; Åkerstedt *et al.*, 1991).

The rotation of the shift system has also been implicated as a factor affecting shiftworkers' sleep. Generally, permanent night and rotating shifts result in more sleep problems than permanent day shifts (Chan, Phoon, Gan and Ngui, 1989; Wilkinson, Allison, Feeney and Kaminska, 1989). In a meta-analysis of shiftwork and sleep length based on 36 primary studies, Pilcher, Lambert and Huffcutt (2000) reported that when the types of shifts were collapsed, within both the rapid and slowly rotating schedules, the same basic pattern of negative effects seen in permanent shifts emerged. Night shifts had the most detrimental effects and resulting in a decreased sleep length (as in permanent night and evening shifts) whilst morning shifts resulted in a moderate decrease. In contrast, Folkard *et al.* (1991) reported the sleep of early morning shiftworkers to be worse than the day sleep of nightworkers. More recent studies have also investigated the effect of shift length on sleep with preliminary studies showing that sleep length is decreased following 8h compared to 12h shifts (Axelsson *et al.*, 1998), although Gillberg (1998) found that 12h nightworkers had the fewest sleep problems overall, whereas those working 12h days reported more difficulties in terminating sleep before their shift (especially the first shift).

Research into the sleep habits of shiftworkers show a different pattern of behaviour before, between and after shifts. Knauth, Landau, Dröge, Schwitteck, Widynski and Rutenfranz (1980) conducted a time budget study in 8 groups of shiftworkers, analysing 9,480 diary records of 1,230 workers. Day sleep taken before the first night shift was the shortest, lasting for an average of only 2.1h, was highest between two consecutive night shifts, at an average of 6.1h, and dropped back down after the last night shift, with a mean of 4.2h. In contrast, the night sleep of the first and the final morning shift did not vary considerably, showing an average of 7h and 7.6h, respectively.

2.2.3. Mechanisms of Sleep Problems

In the same way that the shift system itself can influence the extent of sleep problems incurred, a number of other intervening variables have also been associated with shift-related sleep difficulties. These can be roughly grouped into 3 main categories: biological, situational, and individual (the latter two of which receive further attention in Chapter 3, and therefore are only briefly summarised here). Although these are discussed separately it should be borne in mind that such factors are not necessarily mutually exclusive but can work independently or in combination in producing adverse effects.

2.2.3.1. Circadian

Under normal circumstances, the sleep-wake cycle, like many physiological and psychological variables, exhibits a circadian rhythm (Wever, 1979). Maintenance of this rhythmicity is achieved by two main components, the endogenous body clock and the exogenous *zeitgebers*, or time givers (including the light-dark cycle, mealtimes and social interaction) which help the body clock to synchronise around the 24h day. Under normal dayworking circumstances, these two components are in phase with one another, reaching their peak and their troughs at the same time, although in cases where they fail to coincide they nevertheless exhibit a phase relationship, remaining in synchrony with one another. It is a logical presumption, therefore, that any factor which causes an imbalance between these two components will result in a displacement of normal bodily functions, generally most evident with regard to the sleep-wake cycle. Shiftwork, especially that including nightwork, has been purported to be a major disruptive factor in this respect, since it forces the displacement of the sleep-wake cycle from its normal diurnal routine.

A number of authors have argued that the body clock varies the ease with which sleep can be promoted and maintained during the course of the 24h day. Åkerstedt *et al.* (1981) reported that the more sleep was postponed from the usual evening time towards noon the following day, the more truncated it became, but when noon was reached the trend reverted. Thus the evening hours were found to be more conducive to sleep (yielding 8-11h), morning to noon bedtimes were most hostile (yielding 4-5h) and afternoon and night bedtimes fell in between. Such findings support the theory of Lavie (1986) who suggested the existence of a 'forbidden zone' that lowers the propensity to sleep at certain times. Indeed during this time, sleep is almost impossible even though the individual may be feeling drowsy. Such forbidden zones are terminated by two 'sleep gates', sudden and dramatic increases in sleep propensity, that show a bimodal pattern, the first occurring in the afternoon around 14:00 (often equated with the 'post lunch dip' in alertness), and the second between the night-time hours of 21:00-04:00.

In support of such a theory, Maury (1991 cited in Folkard *et al.*, 1993) found that, although the morning shift started at 04:00, workers nevertheless retired to bed at a relatively normal time (around 23:00). When asked why they had not retired to bed early in anticipation of the early start, most complained that when they had tried to do so they had been unable to fall asleep. Folkard *et al.* (1993) found a substantial correlation between both sleep duration and its termination, and the time at which individuals had to leave home. Regression analysis indicated that for every hour earlier that workers had to leave home, they went to bed 5.3 minutes earlier, slept for 46 minutes less and awoke 8.7 minutes earlier. Since circadian type and domestic circumstances (marital status and presence/absence of children) had no reliable effect on sleep onset time, Folkard *et al.* concluded that sleep onset time was influenced by the presence of a forbidden zone.

The timing of the forbidden zone is not exact however, and has been shown to be influenced by a number of variables. Habitual sleep time is one such variable in this respect. For example, Lavie and Segal (1989) have shown the timing of the sleep gate to vary according to circadian type (morning vs. evening type). Others have shown sleep propensity to correlate highly with the phase of circadian rhythm in body temperature, a finding that has received support in free-running, spontaneous desynchrony, forced desynchrony and ultra-short sleep-wake cycle protocols (Carskadon and Dement, 1975; Czeisler, Weitzman, Moore-Ede, Zimmerman and Knauer, 1980; Gillberg and Åkerstedt, 1982a, 1982b; Lavie, 1986, 1989; Strogatz, Kronauer and Czeisler, 1987; Dijk and Czeisler, 1994, 1995). Lack and Lushington (1996) reported a negative correlation between sleep propensity and body temperature, such that sleep propensity was highest around the nadir (in the early morning) and lowest at the peak (approximately 8 hours before the minimum temperature), suggesting that the rising phase of the temperature rhythm interfered with sleep (Åkerstedt *et al.*, 1990). In an EEG study of the day and night sleep of train drivers on irregular work schedules, Åkerstedt and Gillberg (1985) found the longest sleep duration in connection with evening, and the shortest after morning bedtimes. However, they also found a rhythm of sleep termination reaching a peak around noon and afternoon coinciding with a peak in temperature and alertness rhythms, and a nadir between midnight and early morning, coinciding with the trough in temperature and alertness. This midday peak was corroborated by Foret and Lantin (1972) who, again assessing train drivers, concluded that they woke at about noon, whatever time they went to bed. Although the authors considered the possibility that the early termination of sleep may have resulted from external variables, the fact that the data from Åkerstedt *et al.* were obtained under disturbance-free laboratory conditions suggests that the shortened daytime sleeps were a result of the existence of an internal circadian rhythm.

Implications of such evidence for the shiftworker are that, not only does their work schedule limit the available timing of sleep and wakefulness, but the circadian rhythmicity of the body may also prevent sleep from occurring at the times that suit them best. Indeed, it appears that the time they retire to bed may be more important than the amount of rest they attain. Such findings help to explain the decreased duration of the nightworkers' day sleeps since such a shift demands the most radical change in the sleep-wake cycle, forcing a complete inversion of the day and night-time routines. Therefore, in addition to the environmental cues telling the body to be awake, biological constraints are also at play in the form of the forbidden zone. If the worker does manage to sleep, its timing will coincide with the rising phase of the temperature rhythm, leading to the premature termination of rest by the mid-afternoon sleep gate.

On the other hand, despite the fact that the evening hours are thought to be more conducive to sleep, given the fact that light and societal activities are both fading and that rest occurs during the trough of the temperature rhythm, early shiftworkers are not without their own problems. It is well established that early morning shiftworkers fail to phase advance their bedtimes in line with the shift, although evidence suggests that even if they did attempt to go to bed early, their ability to fall asleep would be severely hampered by the forbidden zone. The early start time to the shift forces the worker to truncate the latter part of sleep (containing a high proportion of REM sleep). REM sleep is characterised by EEG desynchrony, complete lack of muscle tone, unresponsiveness, and dreaming, and so premature arousal may lead to difficulties awakening. Furthermore, although the functions of REM sleep remain controversial (Carlson, 1991) the fact that a reduction in this sleep stage has been linked with depression (discussed in detail later), suggests that workers who truncate their sleep in this way may suffer more psychological problems as a result of working shifts.

Afternoon or day sleep, in contrast, conforms to the endogenous and exogenous influences, since the late start time to the shift allows the worker to go to bed later in the night (therefore standing a better chance of coinciding with the night-time sleep gate) and to rise in harmony with the temperature rhythm. Consequently, few problems are reported.

According to Foret and Benoit (1980) "Sleep is a complex phenomenon and its description requires many parameters" (pp. 49). In support of this several authors have argued that sleep propensity can also depend on a number of additional homeostatic parameters, such as the amount of prior wakefulness before sleep, sleep loss and the cumulative sleep deficit incurred throughout consecutive shifts (Åkerstedt, 1985; Mahan *et al.*, 1990; Åkerstedt, Kecklund and Knutsson, 1991; Kiesswetter, 1993; Lack *et al.*, 1996; Dumont, Montplaisir and Infante-Rivard, 1997). For instance, in a study of permanent night nurses, Barton, Spelten, Totterdell, Smith and Folkard (1995) found sleep duration to be directly influenced by the number of consecutive nights shifts, such that as the number of nights increased so too did the duration of sleeps. Maasen, Meers and Verhaegan (1980) reported that the number of sleep interruptions during a week of night shifts decreased towards the end of the week, although subjects continued to complain that the sleep they obtained was not refreshing enough.

However researchers studying other parameters, such as performance, have suggested that successive night shifts cause progressive sleep deprivation with very little overall adjustment (Wilkinson *et al.*, 1989) and that the temperature rhythm, typically used as a circadian marker of adaptation in the shiftwork literature because of its strong endogenous component, adjusts slowly and never fully adapts - merely flattening over time (Van Loon, 1963; Foret and Benoit, 1978; Dahlgren, 1981a). Thus, in rapidly rotating schedules temperature shows a very small adjustment but increases with longer periods of nightwork (Colquhoun, Blake and Edwards, 1968; Knauth and Rutenfranz, 1976).

Logic dictates that the longer the individual has been awake prior to their main sleep, the more tired they will be and the easier they should find it to sleep. Thus the nightworker who has had a truncated day sleep should find it easier to sleep than the nightworker who has had a long day sleep. This is perhaps most commonly observed in the negative correlation between napping behaviour and subsequent length of the day sleep, with shorter sleeps leading to more frequent naps (Åkerstedt, Torsvall and Gillberg, 1981). Indeed, Chan *et al.* (1989) found napping behaviour to be related to subjective sleep quality, sleep length, and the onset of the main sleep, such that napping was much more common in those who did not sleep well. That this was a topping up mechanism was asserted by the finding that, although nappers had short main sleeps, when combined with their nap lengths, total duration between nappers and non-nappers did not differ. However the positioning of such naps is a matter for further research since, according to the prior wakefulness theory, a nap taken too close to the main sleep may reduce sleepiness and therefore hamper sleep propensity.

The effect of sleep loss on the internal structure of sleep has also been studied in relation to shiftwork. For instance, Åkerstedt and Gillberg (1986) found that a short night sleep increased the amounts of Stage 2 and REM of the subsequent day sleep (Webb and Agnew, 1975; Åkerstedt *et al.*, 1990). Slow Wave Activity (SWA), in contrast, is not affected until sleep is severely curtailed (Borbély *et al.*, 1981) and is the only variable to recover the same amount during day sleep as has been lost through prior night sleep. Indeed, Åkerstedt *et al.* (1990) posited that the SWA of a sleep cycle "is a function of the prior time awake minus the amount of SWA already obtained" (pp. 329).

According to Tepas *et al.* (1990) the common practise of concentrating on the workday sleep behaviour of shiftworkers may be detrimental to our understanding of the adjustment process, since, without the constraints of fixed work hours, individuals have more flexibility in their sleep during rest days and alter their sleep strategies as a result. Permanent nightworkers typically revert to sleeping at night and being awake during the day in order to spend time with friends and family. In reality this means that the worker rotates forward on rest days and backwards on workdays, in effect placing him on a discontinuous rotating shift pattern (Van Loon, 1963; Pilcher *et al.*, 2000). The adverse consequences of such a practise are akin to working in San Francisco and returning to London for days off (Waterhouse, Folkard and Minors, 1992), a time difference of 8h. In the words of Tepas *et al.* "Given the sleep strategies currently selected by most workers, it might be argued that *discontinuous* permanent night shiftwork is perhaps the worst possible rotation schedule" (pp. 205).

2.2.3.2. Situational

The fact that shiftworkers alter their sleep behaviour during days off supports the argument that additional needs are not being adequately met by workday sleep strategies. Although the chronobiological explanation is an attractive one, situational factors that exert pressure on the worker to alter his sleep habits in order to fulfil responsibilities and desires, offer an alternative, though not mutually exclusive, approach. Whilst individuals may have difficulty falling asleep and maintaining sleep because they are at the wrong point of their circadian cycle, environmental conditions both at work and at home further add to these problems. Kiesswetter, Seeber, Golka and Sietmann (1997) investigated the effects of occupational exposure to organic solvents on the subjective sleep quality of shiftworkers. Those who had been exposed to acetone demonstrated clear decreases in the depth and quality of their daytime sleep, in comparison to non-exposed shiftworkers. Whilst the mechanism behind such an effect has centred around the pharmacologic influence of solvents on the central nervous system, the de-arousing and narcotic effects of many industrial substances has also been discussed (Kiesswetter *et al.*, 1997). Toxicological effects of shiftwork are discussed in greater detail in section 2.4.6.

Seasonal differences have also been linked to the shortened day sleep of shiftworkers. Kolomodin-Hedman and Swensson (1975) showed longer sleep durations during the winter months on morning, afternoon, and night shifts in addition to days off. However, in an investigation of shiftworkers in the Arctic, Andersen, Chambers, Myhre, Nicholson and Stone (1984) found a trend towards less restful sleep during the autumn and winter.

Noise has also been shown to be a primary determinant of poor sleep in day sleepers (Koller, Kundi, and Cervinka, 1978) although disturbed sleep following night shifts has also been demonstrated under optimal laboratory conditions, suggesting that it may only be a contributory factor (Åkerstedt and Gillberg, 1981). Despite this, Lee (1992) reported that 80.2% of women on rotating and night shifts reported mid-sleep awakenings due to noise. When questioned as to the source of noise interference, crying and screaming of children and road traffic were most often mentioned, although the telephone, door bell, air traffic, electric household appliances and noise from other members of the family/neighbours have also been reported (Knauth and Rutenfranz, 1972; Nachreiner *et al.*, 1975). It is perhaps not surprising therefore that noise-disturbed sleep is common in poor housing conditions, especially in overcrowded built up areas (Knauth and Rutenfranz, 1975). In a different approach Torsvall, Castenfors, Åkerstedt and Fröberg (1987) demonstrated that sleep disturbance can result from the mere anticipation of noise. They studied the sleep of marines on night watch duty and found that such shifts, especially when punctuated with alarms, reduced ratings of sleep length, sleep quality and recuperation. Interestingly however, sleep was also perceived as disturbed when no alarms occurred, an effect the authors termed 'apprehension stress'. Applying such findings to shiftworkers, might it not be the case that those on early morning shifts have disturbed sleep characterised by frequent awakenings because they are anticipating the alarm sounding in the morning?

Domestic responsibilities (e.g. household duties, number and age of dependants) as a source of sleep disturbance have received much attention throughout the literature, typically in discussions on the 'double burden'. Despite attempts to gain equality between the genders, there still exists an unequal distribution of labour, such that women have more domestic responsibilities in relation to their male counterparts. Thus, the effects of household and maternal duties on the sleep of shiftworkers has been studied in females exclusively. On average, female shiftworkers have been found to give family oriented activities priority over day sleep, resulting in a sleep deficit of approximately 1h 20 minutes in comparison to males (Gadbois, 1981; Oginska *et al.*, 1993). Indeed, Andersen and Bremer (1987) reported longer sleep durations in 70% of shiftworkers without children but in only 22% of those with. Moreover, Lee (1992) reported that childcare responsibilities, rather than poor sleep hygiene, contributed to differences in sleep disturbances of nurses in a variety of shift schedules, whilst Beerman, Rutenfranz and Nachreiner (1990) and Costa, Olivata, Peroni, Mossini and Gonella (1991) found a significant inverse relationship between sleep length and the number of children, especially with regard to afternoon shifts, suggesting that females with children are not afforded the opportunity to lie in before an afternoon shift because they have to be up early to tend to the children.

2.2.3.3. Individual

There are a myriad individual difference factors affecting the sleep of shiftworkers. These range from the ability to sleep at different times of the day and night ('rigidity' vs. 'flexibility'), the ability to overcome drowsiness ('languidity' vs. 'vigouressness'), morningness-eveningness, extraversion-introversion, habitual sleep need (long vs. short sleepers), age and gender. Moreover, many of these factors have been found to work in combination in affecting a shiftworker's ability to sleep. Such findings are the subject of Chapter 3, where a comprehensive review is presented.

Whether length of exposure to nightwork has a detrimental effect on sleep has been studied in relation to both former shiftworkers and current shiftworkers who have had extensive nightwork experience. The majority of these have shown that, contrary to the presumption that long term exposure will aid adaptation, increased length of service results in a worsening of sleep quality, even where age is controlled for (Åkerstedt and Torsvall, 1981; Foret, Bensimon, Benoit and Vieux, 1981). Dumont *et al.* (1997) explored the relationship between past nightwork experience and present quality of sleep in a questionnaire study of nurses working on an evening or a day schedule. Findings showed an increase in insomnia for those nurses who had worked more than 5 nights a month for 4-10 years, whereas in those who had worked this regime for more than 10 years incidence of insomnia was low, suggesting that those with longer experience learned to adapt to a greater degree. When sleep was recorded in the laboratory, former nightworkers showed a reduction in SWS, irrespective of whether they had subjective sleep complaints. This led them to conclude that working at night may result in chronic sleep problems where experience is long and includes a substantial number of night shifts. This was supported by Marquie and Foret (1999) who reported former shiftworkers to have more problems falling asleep and waking early compared to those who had never been involved in shiftwork. However, contradictory evidence was presented by Webb (1983). In a study of the potential effects of extensive night shift experience on sleep in later life, Webb compared the structure and subjective evaluations of sleep of 50-60 year old nurses with varying amounts of night shift experience, with age-matched nurses who had no experience. The high shift group were not found to have a higher level of self-reported complaints - in fact the opposite was true, they were actually better sleepers. When the structure of sleep was compared, however, those with extensive experience had REM episodes that were characteristically reduced and shortened. Of course such inconsistencies may, in part, be due to the opting out of shiftwork of those people who were unable to adapt and had the severest problems – the so-called 'healthy shiftworker effect'.

2.2.4. Putting Knowledge Into Practise

While sleep problems in shiftworkers have been extensively documented, little work has been directed towards determining how such complaints might be minimised. Of those that do exist, the majority prescribe the adoption of sleep hygiene strategies such as maintaining a regular sleeping time, a proper sleep environment, regular and balanced meals, avoidance of alcohol and caffeine prior to sleep, avoidance of bedtime worrying, and using the bedroom for sexual activity and sleep only (Wedderburn, 1991). In an attempt to determine whether there was a relationship between sleep hygiene and sleep length, Greenwood, Rich and James (1995) assessed the alcohol, caffeine and tobacco intake, exercise, activities before going to bed, and measures to enhance sleep in a group of rotating shiftworkers over the first three days of their night and day shifts. In general, workers followed recommendations concerning alcohol intake, sleeping immediately upon going to bed and exercising, but acted contrary to recommendations concerning caffeine and nicotine intake. In particular, of the behaviours studied, only alcohol intake and physical activity taken 6h prior to sleep differed following the night shift, the former being modified and the latter not. The only behaviour clearly associated with poor sleep was smoking (found to reduce sleep length).

The term 'optimal sleep-wake patterns' although somewhat misleading, has been used by several authors in their quest to recommend strategies that may minimise the sleep disturbances of shiftworkers. Generally these interventions fall into two categories, personal strategies, involving the commitment of the shiftworker himself, and organisational strategies, involving the design of the shift schedules. According to Åkerstedt (1998) there are 4 main personal strategies that shiftworkers can use in order to achieve their optimal sleep. The first is to extend day sleep by improving the sleep environment (shutting out noise and light as much as possible, for example), although as he admits himself, such a suggestion has not been empirically tested in real life situations. Furthermore, of those studies that have looked at a similar concept the majority have concluded that it may be of little utility. Main sleeps are generally cut short for a reason, to join in with the family meal or simply through the circadian termination of sleep. Thus, while it sounds good on paper, such a strategy may be extremely difficult to achieve.

The second strategy is to supplement the main sleep with a nap during the day, a practise often termed 'split-sleeping'. Naps, whether taken consciously or unconsciously, are widespread amongst the shiftworking population and are often used as investments for later or to compensate for lost sleep. However little is known about the effects of napping and much of the evidence to date has been based on laboratory studies. Such studies have highlighted the importance of naps, with benefits including improvements in reaction time, short-term memory, and subjective ratings of sleepiness and mood (Taub, Tanguay and Rosa, 1977; Carskadon and Dement, 1986; Bonnet, 1991; Gillberg, Kecklund, Axelsson and Åkerstedt, 1994; Bonnet and Arand, 1995), although some have found no effects (Bertelson, 1979; Dinges, Orne, Evans and Orne, 1981a) and others have noted increased difficulties initiating sleep and impaired performance (Smith and Wilson, 1991). The issue is complex and questions as to the optimal timing within the circadian cycle and duration remain unanswered. Gillberg and Åkerstedt (1981b) found that the circadian upswing of performance and alertness during the day is capable of counteracting the effects of up to 2 nights without sleep. Thus naps taken during the day, when there is limited sleep deficit, are taken during the circadian upswing of alertness and may be of little benefit. However, naps taken during the night when the body is programmed for sleep may be easier to initiate and provide more long-term benefits. Indeed, Angiboust and Govars (1972) found that a nap taken at 24:00 led to improved vigilance performance between 03:00 and 05:00, while Gillberg (1984) found that a nap taken between 04:30 and 05:30 returned performance to the level observed at 17:00.

The duration of naps has also been a matter of contention within the literature, made all the more difficult to assess because many authors fail to report the length of naps taken by their cohort. According to Åkerstedt (1998) "20 minutes may be as valuable as 2 hours" (pp. 22), while Gillberg (1985) states that "the duration of a nap does not seem critical...1-hour and 2-hour naps have roughly the same effects" (pp. 85). However, many authors agree that the time *between* waking from a nap and starting work is critical since a short interval (20-30 minutes) may result in sleep inertia, the poor ability to perform tasks immediately after waking (Dinges, *et al.*, 1981a, Naitoh, 1981; Naitoh, Kelley and Babkoff, 1993). Smith and Wilson (1991) assessed whether taking a nap in the middle of the night produced a long-term benefit in mood and performance in a group of nurses working night shifts as part of a rotating schedule. When performance on a logical reasoning task was measured in non-nappers and 15 minutes after waking in those who had napped, the latter group were slower. This pattern was reversed at the end of the shift. In the same way, those who took a nap felt more depressed and less attentive upon waking than those who remained awake, but again, this was reversed at the end of the night. This led them to conclude that taking a nap in the middle of the night shift can lead to short-term impairments but long-term benefits.

In the same way that naps can be beneficial, evidence suggests that a nap taken too close to the main sleep may impair the ability to initiate sleep, indeed we have already discussed the effects of prior wakefulness on the ability to sleep. According to Åkerstedt and Folkard (1996) this is because, with later napping, the recovery period starts from a higher level of alertness and reaches the sleep termination threshold earlier. Laboratory studies have also shown that those who napped had a shorter main night sleep in addition to less SWS and REM (Bonnet, 1991, Bonnet *et al.*, 1994).

Rather than extending the main sleep or splitting sleep, a possible alternative for the shiftworker would be to delay sleep, the third strategy suggested by Åkerstedt (1998). In this way, instead of going to bed immediately after returning home the nightworker would delay sleep to the afternoon, in effect changing their sleep strategy from work-sleep-leisure to work-leisure-sleep. According to a number of authors the structure of sleep differs depending on whether it is taken in the morning or afternoon. Morning sleep has been found to have more REM sleep than afternoon sleep, whilst the latter tends to have more Stage 4 (Webb and Agnew, 1967; Webb and Agnew, 1971; Taub and Berger, 1973; Hume and Mills, 1977) although Knauth, Kiesswetter, Bruder, Romberg and Rutenfranz (1980) did not find this to be the case. In an experimental study simulating nightwork conditions, Kiesswetter (1993) compared the effects of morning versus afternoon sleep regimes on sleep quality within and after a period of seven night shifts. Using polysomnographic and subjective measures, no significant differences between the self reported recovery of morning and afternoon sleepers were found, although the latter did have shorter latencies for Stage 3 sleep and high levels of SWS. They also had less difficulties falling asleep, which the author attributed to the longer waking interval compared to the morning sleepers. He concluded that there is "no general rule as to whether morning or afternoon sleep is more beneficial" (pp. 271). It is also important to remember however, that shiftworkers often interrupt sleep for social and domestic reasons, therefore, even if delayed sleep did prove to be more beneficial than morning sleep, many shiftworkers may still interrupt this sleep in order to join in with the family meal or to socialise before work. This, like all other sleep strategies, require a commitment to shiftwork which many workers may be reticent to give, even if they prove to be beneficial.

The fourth and final strategy recommended by Åkerstedt (1998) was specific to those working the early shift and addressed the problem of having to phase advance the bedtime in order to obtain an adequate night's sleep. Since going to bed early means that sleep is brought close to the forbidden zone, Åkerstedt recommends that a curtailment of the previous night's sleep episode will lengthen prior wakefulness and therefore shorten sleep latency. Such an experiment has yet to be attempted.

A number of reviews on the ergonomic design of shift schedules have been published, although unfortunately it is beyond the scope of this chapter to offer a comprehensive review of such recommendations (the interested reader is referred to publications by Knauth and Rutenfranz, 1982; Knauth, 1993). However, since a number of these propositions have implications for improving the sleep of shiftworkers, the general trends in this research, and specifically those pertaining to rotating shifts, are touched upon here.

Based on the finding that the circadian adjustment to a phase delay is 50% quicker than the adjustment to a phase advance (Aschoff, Hoffman, Pohl and Wever, 1975), many have advocated that a clockwise (forward) rotation is better suited to the human circadian clock than a counter-clockwise (backward) rotation (Monk, 2000). Forward rotations also have the added advantage of allowing more time between changeovers, since the backward rotation from afternoons to mornings only allows 8h between shifts, whilst the changeover from mornings to afternoons allows 24h, giving more time for recuperation.

In terms of the speed of rotation (the number of consecutive shifts worked before a change), both slow and rapid rotation have received support, although there remains a great debate as to which is more beneficial for the shiftworker. On one hand there are those who advocate that a slow rotation is better as it allows at least some adjustment, rather than the complete disruption seen in rapid rotations (Knauth and Schmidt, 1985; Williamson *et al.*, 1986, Tham and Thierry, 1993; Pilcher *et al.*, 2000). On the other hand, those in favour of the rapid approach argue that although it makes the schedule more irregular, it does not require the worker to adapt their circadian rhythms to new work times, making it easier to change shifts, and avoiding cumulative sleep debt (Knauth *et al.*, 1982; Kogi, Miura and Saito, 1982; Tilley *et al.*, 1982; Åkerstedt, 1985; Williamson and Sanderson, 1986; Knauth and Kiesswetter, 1987; Chan *et al.*, 1989; Knauth, 1993; Hornberger and Knauth, 1995, 1998). Indeed, Smith, Wright, Mackey, Mislop and Yates (1998) found the change from a slow to a fast rotation was supported by 83.3% of shiftworkers, whilst Hornberger *et al.* (1998) found an even higher proportion of 98%. Tham and Thierry (1993) suggested the possibility of using both fast and slow rotations within the same schedule. They argued that a rapid rotation for the night shift was preferable since it prevented adjustment through inversion of the circadian rhythms, whereas, given that the sleep deficit incurred from the morning shift would increase with every morning shift worked, a slow rotation would also lead to more problems in this shift type. In contrast, for the evening shift, a slow rotation would give the worker more opportunity to use their valuable evening leisure time.

A final argument in the scheduling of shiftwork is whether rotation is better than permanent. Although, to a large extent this depends on the preferences of individuals involved, both have their merits and their weaknesses. Rotating systems bring variety but at the expense of circadian disruption, whilst permanent systems allow a higher level of adjustment but only in those who are committed to maintaining the same routines on days off.

2.2.5. Criticisms

Whilst research in this area has been extensive, it has not always been methodologically sound, in terms of the settings and the measurements used. Many of the studies have used laboratory based simulations of shiftwork which are not strictly comparable to real life settings. Indeed a number of authors have noted that most of these studies do not observe the shortened day sleep characteristic of shiftworkers (Tilley *et al.*, 1982). Moreover, although laboratory studies generally attempt to put subjects at ease, they are, by their very nature, artificial and unfamiliar settings, involving strict scheduling of the sleep-wake routines. In most cases shiftworkers get out of bed as soon as they wake up, whereas the laboratory subject usually has a fixed time allotted for staying in bed. Such circumstances may prevent truly spontaneous patterns emerging (Åkerstedt *et al.*, 1991). Furthermore, laboratory studies reported in the shiftwork literature have traditionally used young student subjects, yet shiftworkers tend to be older and there are well established age related sleep differences.

There are also variations in the social pressures of each group which further hamper the ability to generalise from the results gained from experimental research. Although experimental studies are useful in isolating time of day effects from intervening variables, such as noise and situational circumstances, one must remember that such variables are part of the shiftworker's lifestyle and, as such, contribute to their problems. Thus rotating a shift rapidly to reduce the accumulation of sleep loss may benefit the feelings of tiredness but will in effect ruin any opportunity the worker has to establish a social life. Far from being isolated from one another, situational and circadian factors go hand in hand for the shiftworker and should be researched as such. To date only a handful of authors have attempted to monitor the sleep of shiftworkers in their own homes (Åkerstedt and Gillberg, 1981; Tilley *et al.*, 1981; 1982; Åkerstedt *et al.*, 1991).

For practical and technical reasons, the majority of studies assessing the sleep of shiftworkers have been confined to subjective questionnaires or objective polysomnographic measurements. Although EEG measurements are typically taken in experimental settings and, as such, are beset by the disadvantages noted above, they have the advantage over self-report measurements of being 'pure' rather than 'perceived'. Linked to this is the bias involved in comparing shiftworkers and non-shiftworkers. Apart from the well established problem of the migration of ill adapted shiftworkers to daywork, an additional problem of comparing shiftworkers and dayworkers lies in the idea of what is 'normal'. Since dayworkers and shiftworkers have different experiences of work-related problems, they will also differ in their frames of reference as to what is 'abnormal'. According to Åkerstedt and Gillberg (1981) research should employ *within* group rather than *between* group comparisons.

2.2.6. Disturbance or Disorder?

DSM-III-R contains a diagnostic category for "sleep-wake schedule disorder, frequently changing type" (pp. 306-307) that refers specifically to shiftwork. The American Sleep Disorders Association defined shiftwork sleep disorder as "any complaint of insomnia or excessive sleepiness associated with working during the habitual sleep phase, usually night work" (pp. 118) and according to Åkerstedt (1991) "the sleep disturbances of shiftwork would, in most cases, reach the criteria for clinically diagnosed insomnia if the causes could be identified as external" (pp. 266). Yet whether the extent of the shiftworkers' sleep problems actually constitute a disorder rather than a disturbance is a matter of some debate (Webb, 1989; Regestein and Monk, 1991). Both terms are used freely in the literature without much regard for the fundamental difference between the two. For whilst a disturbance tends to be a transient complaint, a disorder has more serious undertones, often used to denote "a malfunctioning of the body, an ailment or illness" (Chambers English Dictionary, 1997).

Whilst sleep complaints of shiftworkers could, on one hand, be seen to be analogous to the occupational hazards entailed in other work situations such as bomb disposal, virus research or asbestos processing, Regestein *et al.* (1991) argue that such hazards are typically increased risks for injury rather than disturbances per se, and as such are accepted by employers and legislators who seek to prevent them. Sleep complaints of shiftworkers, in contrast, although often undeniably a direct result of the work schedule, are more acceptable and, in most cases, are seen to be the fault of the worker himself. Furthermore, that such sleep problems are frequently seen within the shiftworking population further adds to the idea that they are not abnormal and therefore should not be treated as such. Such a situation is not helped by the fact that many shiftworkers remain silent about their problems and rarely visit sleep clinics, suggesting that they themselves accept their sleep problems as simply part of the job. Indeed, Regestein *et al.* found that during a 5 year period, from 1985-1990, only five patients at a sleep clinic that evaluated approximately 120 patients annually, presented sleep disturbances associated with nightwork.

Some authors have compared the problems of shiftworkers with those who frequently take transmeridian flights, and incur jet lag as a consequence. According to Czeisler and Allan, (1987) both jet lag and shiftwork require a shifting of the circadian phase, whilst Wever (1980) argued that the problems of readjustment following schedule displacement are similar in both jet lag and shiftwork situations. Despite similarities in aetiology, the process of adjustment is very different. Air crews often benefit from the readjustment of zeitgebers, such as the light-dark cycle, mealtimes, and social cues in their destination which positively encourage readjustment, whereas the time cues of the shiftworker remain rigid. Adjustment is also further impaired by the fact that many shiftworkers, especially those working nights, return to their normal daytime routine at weekends. Thus whilst the problem of jet-lag is acute, those of shift-lag are chronic. Recent evidence of great interest here, however, is the finding that frequent jet-lag can shrink parts of the cortex and hippocampus, resulting in short-term memory deficits and slower reaction times, and accompanied by high levels of the stress hormone cortisol (Cho, 2001). Insufficient recovery time, similar to that found in many shiftwork schedules, is purported to be the major cause.

Thus, whether the sleep complaints of shiftworkers should be considered to be a disorder remains controversial. Evidence presented to date suggests that, whatever the classification, the problems incurred are chronic and result from work schedules imposed on otherwise normal individuals. In reality, the only reason to clarify the definition is to increase the shiftworkers plight and to highlight the fact that, whilst sleep problems may not be abnormal in the shiftworking population, compared with individuals on more regular work schedules, they are very different. Many people are aware of the feelings associated with jet-lag, but at least these feelings diminish. For the shiftworker they are ongoing. The term 'disorder' provokes much more attention and interest than the term 'disturbance', and it is this recognition that needs to be injected into research, so that sleep complaints become less acceptable and a matter requiring intervention and legislation. The present situation merely underlines the fact that shiftworkers are often a forgotten section of the community who have a unique set of problems as a result of the hours they work. By introducing the fact that disorders can result from the hours they work their plight may be brought into the spotlight.

2.2.7. Conclusion

That there is a circadian component to the sleep problems of shiftworkers is evidenced by the fact that those shift schedules which impose the most circadian disruption, the night, early and rotating shifts especially, are the ones also associated with the most extensive problems. However, situational circumstances and characteristics of the individuals themselves also play an important role in influencing their adaptation to shiftwork as a whole. Irrespective of the ways in which these variables work either separately or in combination with each other in producing their effects, the fact remains that man, as a diurnal animal, is not designed to sleep at abnormal hours and has major complications in adjusting outside of a diurnal routine.

2.3. Safety and Accidents

In the light of such sleep disturbances it is not surprising that there is a wide array of investigative evidence showing that the increased fatigue and reduced alertness resulting from certain types of shift schedules, especially nightwork, can contribute to impaired safety. Indeed disasters that have received worldwide attention such as the nuclear accidents at Three Mile Island (1979) and Chernobyl (1986), the Challenger Space Shuttle disaster (1986), the Exxon Valdez oil spill (1989), and crashes of flights 182 (1978) and 2860 (1977), all share a common feature - whilst the technology and equipment used have been implicated, reports into the causes of these disasters have all identified human performance as a critical contributor, mentioning either sleepiness, inattentiveness, poor decision making or fatigue resulting from long and irregular hours and insufficient rest between schedules. Thus the great appeal of investigating the causes of accidents is that they are typically preventable.

Whilst major catastrophes attain a high profile for the sheer damage they cause, both in terms of the economic and human costs involved, little attention is given to the huge number of accidents that occur daily amongst the workforce. Research in this area has traditionally concentrated on high risk jobs such as nuclear power operators, pilots, professional drivers and nurses. According to the Institute for Circadian Physiology (1990), the price tag of work related fatigue in reduced productivity and industrial accidents is in excess of $77 billion in the US alone. Such claims are difficult to substantiate since few studies have been performed on industrial workers, and those that do exist present a contradictory picture (Carter and Corlett, 1972). Some investigations have reported a higher incidence of accidents on the night shift (Menzel, 1950; Andlauer and Metz, 1967; Pradham, 1969; Quaas and Tunsch, 1972; Smith, Folkard and Poole, 1994; Åkerstedt 1995, 1996) whereas others have found more accidents amongst those on the morning shift (Adams, Barlow and Middlestone, 1981; Pokorny, Blom, and van Leeuwen, 1981), the afternoon shift (Hill and Trist, 1955; Koheygi and Bedi, 1962), and dayworkers (Abelsdorff, 1910; Lee and Cho, 1982). Moreover several studies have reported accidents to be less frequent but more serious during the night shift (Wanat, 1962; Andlauer *et al.*, 1967; Ong, Phoon, Iskandar and Chia, 1987) whilst others still have failed to find any such difference (Wyatt and Marriott, 1953).

Such conflicting results may be due to the fact that accidents, especially minor ones, often go unreported, both by the management and employees themselves, whether for insurance reasons, personal convenience, or a lack of standardised procedures for reporting them. Work site clinics are also typically closed during the evening hours which again may lead to a lower declaration of incidents. However a second explanation is that, in industrial settings particularly, the work environment and nature of the job changes according to different shifts (Colquhoun, 1976;

Harrington, 1978; Carter *et al.*, 1982; Knauth, 1983; de Vries-Griever and Meijman, 1987; Folkard, 1997; MacDonald, Smith, Lowe and Folkard, 1997). Supervision and maintenance are often reduced at night and other environmental factors such as the noise and temperature may vary considerably. There are also often lower manning levels and more automation. Furthermore, long runs of a job (such as the production of a certain item or large batches of routine computer jobs) are often saved for the night shift, which can add monotony to the task. The significance of such work related variations have been highlighted by numerous studies showing performance efficiency to be dependent on the type of tasks involved and not simply on the workers' level of sleepiness (e.g. Kleitman, 1963; Chaucard, 1968; Folkard, Knauth, Monk and Rutenfranz, 1976; Wojczak-Jaroszowa, Makowska, Rzepecki, Banaszkiewicz and Romejko, 1978; Folkard, 1979; Dinges and Kribbs, 1991; Folkard, Totterdell, Minors and Waterhouse, 1993; Maury and Quéinnec, 1993).

2.3.1. Time Of Day (TOD) Effects

TOD has been an important factor in accident research. There is some evidence that accident risk is higher during the night and early morning hours (Smith *et al.*, 1994; Åkerstedt, 1995; Smith *et al.*, 1995), since this is the time when alertness is reduced and the propensity to fall asleep is high. Indeed, a number of accounts have verified the fact that falling asleep on the job is relatively common (Torsvall *et al.*, 1989; Åkerstedt *et al.*, 1991). In a disturbing report by the US Congress, the Peach Bottom nuclear power plant in Pennsylvania was forced to shut down when it was discovered that control room operators had 'periodically slept or been inattentive to duties' during the night shift (US Congress, Offices of Technology Assessment, 1991).

In a review of the temporal determinants of transport safety Folkard (1997), using the only three studies to address performance measures and TOD effects in industrial settings, found the 24h trend in real job performance to be parallel with that in road accident risk, being clearly higher at 03:00 (2 SD's above the overall 24h mean). He argued that such a finding was significant in that the setting of the shiftworker is much more constant than that seen in driving since the worker has adapted to sleeping during the day. This supports the idea of an underlying accident risk due to internal, rather than environmental, origins. The internal mechanism to accident risk has been advocated as the diurnal nature of humans and the well known propensity for sleep at certain times of the day (Mitler, Carskadon, Czeisler, Dement, Dinges and Graeber, 1988; Lavie, 1991; Horne and Reyner, 1995) since, like accident risk, the propensity to sleep is highest during the early hours of the morning and shows a secondary peak in the early afternoon (Lavie, 1986). However, Folkard (1997) argued that the sleep propensity function failed to adequately account for the trend in accidents, since those involving road traffic were less frequent than would be expected from the sleep propensity trend at 08:00, and rather higher than might be expected at 02:00 and 21:00. Furthermore, there was a less pronounced peak in residual risk at 14:00. Neither can the accident risk be equated with a simple sleep deprivation effect. Folkard and his colleagues (1994) found that mean sleep duration was considerably shorter on the morning shift than either the night or afternoon shifts, leading them to conclude that "there would appear to be at least one other, time related, factor that contributes to the pronounced variation in accident risk across the 24-hour day" (pp. 424) – the time on task effect.

2.3.2. *Time On Task (TOT) Effects*

Within research into the TOT effect has been the consistent finding of a non shift-dependent transient peak in accident risk during the first 2-4h of work, superimposed upon an otherwise exponential increase across TOT. However, there is also a second peak in accident risk when hours continue past the normal working day of 8-9h (Murrell, 1971; Folkard and Totterdell, 1991; Wharf, 1993; Åkerstedt, 1995; Folkard, 1996; MacDonald *et al.*, 1997; Hanecke, Tiedemann, Nachreiner and Grzech-Sukalo, 1998; Nachreiner, Akkerman and Hanecke, 2000), doubling after the 12th and trebling after the 14th (Folkard, 1997). Pokorny *et al.* (1981) noted a distinct peak in the accident risk of bus drivers that occurred in the 3rd to 4th hour of time into task which was unaffected by the time they had started work. Hamelin (1987) noted that the risk of accidents in lorry drivers in the first 4h of their shift was higher than all subsequent hours unless the drivers had been working for more than 12. Folkard (1997) combined and standardised the results on several different studies and found a 30% reduction in accident risk from the first 4h to the second 4h on shift. Only when the duties were extended to over 14h did the overall risk exceed that on the 4h duties. On this point one must remember that the shiftworker does not really finish his shift until he arrives home and therefore time spent commuting to and from work also needs to be added onto their total work hours. If the individual has worked a 12h shift and has far to travel, evidence suggests that they will be at a greater risk than a worker who has only worked for 8h, but has the same distance to travel. Accidents on the journey home, according to Monk, Folkard and Wedderburn (1996) represent the major risk of bodily harm in shiftworkers whose actual work may be inherently fairly safe.

Such a trend raises the question of the underlying mechanism, but since there is little research into this phenomenon, any theories, at this stage, remain purely speculative. One possibility is based on the idea of controlled versus automatic processing as suggested by Schneider and Shiffrin (1977). According to this theory performance at the beginning of duty is largely dependent on effortful, controlled processing of incoming information. However, since it requires effort it cannot be sustained over long periods and so decreases monotonically over time. When the task has become re-automised, less effortful, automatic processing takes place.

Since even automatic processing cannot remain stable, this too decreases over time after prolonged duties, due to increased fatigue. The peak during the first 4h of a shift reflects a period during which controlled processing has decreased but automatic processing has not increased enough to compensate for this, therefore, otherwise preventable, accidents occur. The later peak after the 12^{th} hour at work reflects the increase in fatigue which interferes with automatic processing. This has led several authors to conclude that the safest duty durations lie in the region of 8-10h, and lesser or greater than this will result in a heightened risk (Folkard, 1997). Such findings also imply that the long runs of a job often saved for the night shift should, in effect, lead to a lower relative accident risk with TOT, compared with dayworkers, whose jobs can change frequently. Since this is generally not the case, it may be that the combined effects of a flattened circadian rhythm in alertness and high sleep propensity during the night, along with the monotony of such long runs, may have a stronger influence than TOT during the nocturnal hours. Further research needs to investigate whether this is the case.

2.3.3. Intervening Variables

An additional factor linked to the increased accident risk is the way in which time is spent before a shift. As early as 1926, Thorndike concluded that it was difficult to conclude whether the results from his review of the literature on mental efficiency and TOD measured "the inner daily rhythm and how far they measure a rhythm complicated by the influence of a day's work with warming up, fatigue, and suggestions from the habits of the individual and the community" (pp. 64). Dalbokova, Tzenova, and Ognjanova (1995) found that the relatively late start time of 16:00 allowed workers to participate actively in family life. 75% of the nuclear power workers in their study had spent time before the evening shift in domestic activities, with only 18% having taken a nap. According to the authors, such a lack of recuperation from the daytime domestic activities on the operator's functional state could potentially interact with their workload to exacerbate TOT effects. Likewise, in a study of accidents amongst mineworkers, Monk and Wagner (1989) found the number of night shift accidents to gradually decrease, but noted a peak during the Sunday night shift. On examining the off work behaviour of these workers they found that they lived in communities where Sunday was used to attend church and engage in family oriented activities. This prevented them gaining enough sleep in readiness for the Sunday night shift.

2.3.4. Conclusion

In general, the propensity for accidents is greater when both the internal circadian rhythm of alertness and the performance rhythms of the required tasks are at their low point, making it extremely difficult to function adequately and allowing otherwise preventable accidents to occur. However, we are only just beginning to speculate as to the mechanisms underlying trends in accident risk. Whilst major catastrophes such as Chernobyl and Exxon Valdez are still receiving media and research attention to ensure that they do not happen again, the everyday risks that human beings are under in the course of their work goes unrecognised. A disturbing report equated the performance impairment caused by fatigue as similar to that caused by alcohol intoxication, showing that even moderate levels of fatigue caused higher impairments than the proscribed level of alcohol intoxication (Dawson and Reid, 1997). We would not think twice about the risks involved in allowing inebriated workers to manage often dangerous tasks such as nursing intensive care patients, long distance driving or operating nuclear reactors. Future research should not let the label 'shiftworker' fool them into thinking that the necessary protective procedures are in place.

2.4. Health and Well-Being

"Shiftwork is probably bad for the heart and head and definitely bad for the gut"
Monk (1988)

Since there is evidence to suggest that shiftwork causes specific risks to health, and given the fact that over half the lifespan of the average human being is spent in employment, it is not surprising that the health impact of shiftwork has been one of the most extensively studied throughout the shiftwork literature. A major line of inquiry in this area stems from the principle that shiftwork is known to result in disruption of the circadian system, and since a number of physical and psychological functions exhibit circadian rhythms, this represents the most obvious pathway from shiftwork to disease. In contrast, others have emphasised the importance of the social and familial rhythms, as well as individual and situational circumstances. Such viewpoints are discussed later in relation to the models of shiftwork and health that have been generated to date. Within this section we discuss specific disorders that have been studied in relation to shiftwork, such as cardiovascular and gastrointestinal complaints which have become the mainstay of research in this area, in addition to psychological disorders, such as depression. However, we also discuss the relatively 'new' topics of reproductive health and impaired immune functioning that have come to light with more recent advances in the area. Since the outcomes of health problems can range from sickness and absence through to mortality, research which has examined these indices are considered first.

2.4.1. Mortality

In spite of the fundamental importance of such work, there remain few studies of mortality rates in shiftworkers. Furthermore no modern examples exist. Thiis-Evensen (1949, cited in Taylor and Pocock, 1972) compared the average age of death of 498 day- and 212 three-shiftworkers, from 1917 to 1948. Although the author did not compare the figures with national statistics, he nevertheless concluded that shiftwork was not associated with higher mortality rates. Taylor *et al.*(1972) compared both the rate and cause of mortality within a cohort of 8603 male industrial workers from 1956 to 1968. Using the Standard Mortality Rate (SMR) where, on the basis of actuarial data, 100 represents the expected number of deaths in the general population, they found that for dayworkers the SMR was 92, compared with 102 in current shiftworkers, and 132 in former shiftworkers. A similar comparison was also made between observed and expected deaths across different shift types. Although observed deaths were higher than expected, amongst 2-shift, 3-shift rapidly rotating and slowly rotating, they were not significantly so. Differences in death rates according to 10 year age group bands were not consistent in direction. Thus, although there were significantly fewer deaths than expected amongst dayworkers aged 45-54, this was reversed in those aged 55-64. Earlier studies had found no differences in the age of death of shiftworkers and dayworkers (Aanonsen, 1959, cited in Agervold, 1976). On the basis of these results they concluded that "there is no undue mortality among men who have completed 10 years of shiftwork or among those who did between 6 months and then changed to daywork" (pp. 206). However, whilst this study took account of the so-called healthy shiftworker effect, in addition to controlling for both the type of job performed and the length of shiftwork exposure, it may be the case that shiftwork becomes a risk factor for life expectancy in exposures of more than 10 years. Further research comparing the death rates of shiftworkers with different lengths of experience needs to be conducted.

In a rather different approach, Kripke *et al.* (1979), relating mortality to sleep duration, found that those people who slept for 6-6.9 hours a day showed an 11% excess of deaths compared with those who slept for between 7-7.9 hours a day. Although this study examined the population as a whole, such findings have important implications for shiftworkers since it is well established that the majority of individuals complain of sleep problems during their shiftworking career. Additional research could also be conducted into whether the life expectancy of women, known to be responsible for a greater proportion of the domestic burden, may be affected by shiftwork, taking account of their marital status, number and age of dependants, as well as the individual characteristics of the mother (e.g. age, length of shiftwork exposure).

2.4.2. Sick Leave and Absence

The impact of shiftwork on the rate of absence from work and certified sick leave has resulted in various conclusions. Whilst some authors have found dayworkers to have a higher rate of sickness absence (Wyatt and Marriott, 1953; Thiis-Evensen, 1958; Pocock, Sergean and Taylor, 1972), some have found shiftworkers to have a higher rate (Angersbach, Knauth, Loskant, Karvonen, Undeutsch and Rutenfranz, 1980; Lai, 1994) whilst others have found no difference between the two (Taylor, 1967; Pocock *et al.*, 1972; Angersbach, *et al.*, 1980; Koller, 1983; Kleiven, Bøggild and Jeppesen, 1998). A consistent finding, however, is that former shiftworkers (when still working shifts) tend to have higher absence rates (Angersbach *et al.*, 1980; Koller, 1983), perhaps suggesting that they are less able to tolerate shiftwork and leave due to ill health.

As the design of such studies have progressed, aspects of the shift systems themselves have been suggested as possible variables affecting the degree of absence amongst workers. 12h shiftworkers have been found to have a higher long term absence than those employed on 8h schedules (Jozef, 1990), although the opposite was found by Rutenfranz and Werner (1975), whilst nightworkers have been found to have a higher incidence of certified sick leave than those working day or afternoon shifts (Sergean and Brierley, 1968; Walker and de la Mare, 1971). Colligan, Frockt and Tasto (1979) compared the sickness absence and worksite clinic records of over 1199 female nurses assigned to permanent day, afternoon, night and rotating shifts. They found that, relative to nurses on permanent shifts, those on rotated patterns exhibited a significantly higher rate of clinic visits and took more days off due to illness. They also noted that the reasons for sick leave were a function of shift. Those on fixed shifts tended to take time off for relatively minor ailments (e.g. headaches and colds), while those on rotating shifts took time off for more serious ailments (e.g. acute respiratory infections and upper gastrointestinal tract symptoms).

Such findings suggest that absence may be misrepresentative in the rotating shiftworker group in that they may suffer minor ailments more often as a matter of course and, therefore, be better able to tolerate them on a day to day basis. In this way, such complaints may be seen as *a priori* conditions of the job and something they must learn to adapt to. Interestingly, when reasons for visits to the worksite clinics were analysed, Colligan *et al.* (1979) noted that rotating shiftworkers did so for precisely those reasons that the fixed shiftworkers gave as reasons for taking sick leave, suggesting that the former preferred to treat their symptoms and continue working. These predictions are further supported by Andersen (1970) who found that 72% of a sample of dayworkers experiencing physical symptoms reported them to a GP, whereas only 47% of shiftworkers experiencing similar symptoms sought medical attention. Indeed, Agervold (1976) notes that shiftworkers apparently experience the symptoms as nothing but unpleasant side effects to their jobs whereas dayworkers experience them as symptoms of suffering which require treatment. A possible explanation for the observed health problems in shiftworkers may be that they perceive their problems as being a routine part of their job and therefore delay or impede appropriate medical action, which in turn leads to more chronic health outcomes

(Mechanic, 1966). The extent to which the characteristics of shift schedules can affect the perception of illness deserves further study.

Such contradictory evidence highlights the fundamental problems of using crude methods as indices of ill health amongst workers as a measure of morbidity, as has been acknowledged by several authors. Taylor, Pocock and Sergean (1972) argued that sickness absence was not synonymous with morbidity and could be seen as a way of withdrawing from work. Kleiven *et al.* (1998) stated that "We do not question the fact that shift work is a risk factor for disease... [but] the coherence between shift work and sick leave is still unclear" (pp. 132), concluding with the comment that sickness absence should not be used as a proxy for morbidity. The problem was succinctly phrased by Rutenfranz, Haider and Koller (1985) who stated that "in all cases of reduced health associated with shiftwork, it is advisable to distinguish between a lowering of well being and a disease proper" (pp. 201).

A fundamental flaw of employing rates of absence in workers as a measure of morbidity is that they are often quantitative rather than qualitative. More recent work has begun to employ multiple measures of health, examining not just the incidence of sick leave but also the type and extent of complaints. However, even this method is not foolproof since even these measures fail to take account of the organisational, situational or personal variables comparable between the groups being studied. This could, in part, explain the inconsistent findings in the literature. For example, often shiftworkers and dayworkers perform different jobs, with different workloads. This may account for the discordance in rates and types of illness experienced between the two groups (Taylor *et al.*, 1967). Moreover, the provision of worksite clinics and medical facilities may mean that some workers have continuing application of preventative and therapeutic care and therefore, take fewer sick days than those who have to seek medical help outside of work, having typically to take time off in order to make an appointment with a doctor. Linked to this is the provision and level of pre-employment screening. As a result of the work of Thiis-Evensen (1956, 1958) at the Norwegian industrial plant used as a basis for the studies there had been pre-employment screening of individuals until the early 1970's. Those with a tendency toward gastrointestinal or sleep problems had been excluded whilst those with cardiovascular or muscular complaints were not. Such filtering of employees may have affected the expected and observed levels of absence from certain complaints in the plant, who were the subject of a later study by Kleiven *et al.* (1998).

This leads us onto the problem of the 'healthy shiftworker effect', the natural selection of ill adapted workers out of shiftwork. A consistent finding throughout the literature is that former shiftworkers tend to have higher absence rates (Angersbach *et al.*, 1980; Koller, 1983) than current shiftworkers or dayworkers. Although ex-shiftworkers are a valuable source of information they are often excluded from investigation. Even when they are included, the effects may be confounded by the fact that many are transferred onto daywork. In turn, in some circumstances, the dayworking cohort may be made up of a number of ex-shiftworkers who had given up working shifts on medical grounds, making the sample unrepresentative of the effects of true daywork. Thus the work history of participants is of paramount importance.

The level of job involvement and satisfaction was also linked to the health impact of shiftwork in a study by Taylor (1967) who suggested that a shiftworker's involvement and satisfaction with their job may lessen work stress and therefore, heighten their threshold for sickness absence. Such suggestions deserve further study since it suggests that job enhancement may decrease the rate of absence.

Situational variables, such as domestic environment have also been suggested as mediating factors in the rate of absence amongst shiftworkers, especially women. When the number of days taken off through illness was used as an indication of health, Jozef (1990) found that female shiftworkers were statistically worse than their male counterparts. Whilst it could be argued that the inflated absence rate was due to the double burden (taking more 'sick leave' in order to look after the children, for example) these absences may also have been genuine. Again, further research needs to be conducted into this area to determine whether those with greater responsibilities use the opportunity of sick leave as a 'loop hole' in the system allowing them to deal with their non-work responsibilities.

As has been discussed above, there may be differences in the attitude and perception of symptoms between dayworkers and shiftworkers that are often not accounted for in research findings. The fact that shiftwork can affect not only the incidence of illness but also the perception, labelling and reporting of symptoms has dramatic theoretical and practical implications and suggests that whereas shiftworkers tend to under-report the occurrence of physical ailments, dayworkers tend to over-report, taking time off work for relatively minor conditions. Examining the rate of certified sick leave in shiftworkers and dayworkers does not tap into these inconsistencies and therefore, will not be truly representative.

Research should also take account of personal factors, such as age, which has been shown to have an impact upon the health of the individual (Taylor *et al.*, 1972, Jozef, 1990). For example, certain conditions such as coronary heart disease or sleep problems are known to increase with age, irrespective of the work schedule involved. Therefore since the levels of certain ailments may be more likely in one age group than the other, rates of absence between different age groups should form an important part of the analysis.

As is the case with all other problem areas discussed in relation to shiftwork, the impact of shiftwork on the health of the individual is a multifaceted problem and one which needs to be examined in relation to a whole host of confounding variables, both in and out of the workplace. Many studies that have attempted to establish the rates of morbidity of shiftworkers have used crude methods, such as examining the incidence of certified sick leave amongst workers. Subsequent work must heed the warnings that can be derived from the weaknesses in past research and take a more in depth and dynamic approach.

2.4.3. Health Complaints and Shiftwork Exposure

Although the lack of long term controlled epidemiological data on the mortality and morbidity of shiftworkers makes it difficult to fully understand the risk involved in prolonged exposure to shiftwork, several studies have provided evidence showing an increased prevalence of health complaints with increasing experience (Kundi, 1986; Wynne, Ryan and Cullen, 1986; Beerman and Nachreiner, 1990; Nachreiner, Lübeck-Plöger, Grzech-Sukalo, 1995). Knutsson *et al.* (1986) reported that relative risk of heart disease among shiftworkers was higher in those who had been working for 16-20 years compared with those who had been working for 11-15 years. Risk was lowest for those who had been exposed to more than 20 years of shiftwork. Angersbach *et al.* (1980) found that the rate of peptic disease increased in shiftworkers only after 5 years of shiftwork. Meers, Maasen and Verhaegen (1978) obtained subjective health scores from 104 workers who were about to embark on shiftwork in a newly set up wire mill. At 6 months they showed a decrease in their health scores, whilst after 4 years and 4 months the scores had decreased further in the original cohort (64) who remained. Of the 31 who had transferred from shiftwork, subjective health had stabilised to approximately the level recorded after 6 months, characterised by an increase in complaints of apathy, nervousness, fatigue, palpitations and gastrointestinal disturbances.

More recent research has suggested that it is not the number of complaints that increase with shiftwork exposure but their structure. In an analysis of male and female shiftworkers in the German police force, Beerman, Rutenfranz and Nachreiner (1990) found those with little experience showed an unrelated pattern of complaints unspecific to shiftwork, whereas those with 10 years or more experience showed a pattern of complaints that related to circadian disruption, such as sleep problems and gastrointestinal ailments. In a replication of this study, Nachreiner *et al.* (1995) supported the findings in those who had been working shifts for 15 years or more, whilst for those who had been working for less than 2 years the pattern of complaints was less clear. However, in the latter study, the pattern of health complaints developed earlier in females, which the authors linked to the double burden effect.

According to Rutenfranz, Haider and Koller (1985) the development of health problems in shiftworkers can be explained in 4 stages. In the 'adaptation phase' intervening variables such as the quality of sleep, family and social life, work strain, job satisfaction and so on, have the strongest influence over health in the first 5 years of shiftwork, since the individual must adapt to changes in the rhythms of work and non-work activities. In the 'sensitisation stage' (5-20 years of experience) the individuals' attitude towards shiftwork and their level of success in achieving and improving work and family conditions, in addition to developing coping strategies, will determine the incidence of health and well-being. From the 20^{th} year the shiftworker's circumstances will become more constant as a result of successful coping strategies and adaptation. However, according to Rutenfranz *et al.* this is the time at which risk behaviours develop, environmental hazards accumulate and the effect of ageing begins to play an important role in influencing the worker's state of health (the 'accumulation phase'). According to later research by Cervinka *et al.* (1984) the health of shiftworkers in this stage are best predicted by workload, job dissatisfaction, and family problems, whilst in dayworkers risk factors such as smoking and obesity had the strongest predictive value. Finally, the 'manifestation stage' occurs after 40+ years of shiftwork experience and is characterised by a prevalence of gastrointestinal complaints (e.g. chronic gastritis, and gastric/duodenal ulcers).

Very few studies have assessed the impairment of health in shiftworkers over an extended period, yet such work-intensive designs are necessary as a way of conducting an in-depth analysis of the effects of not only shiftwork, but the intervening situational, occupational and personal variables that may interact with shiftwork to influence the impact of the working schedule on health. Whilst Rutenfranz *et al.* have made an important step in attempting to link these features together in a coherent predictive structure, more research into the effects of different levels of shiftwork exposure needs to be conducted in order to identify the most dangerous variables. This knowledge would then be useful in assessing the relative risk of individual shiftworkers before the health problems begin to take hold and cause irreversible damage. As the proverb says "prevention is better than a cure".

2.4.4. Immune Function

That shiftwork may affect the general defence mechanisms of the body is a relatively new topic and, as such, one that has only recently been touched upon in the literature. Nakano *et al.* (1982) found that cellular immunological function of lymphocytes in peripheral blood shows a circadian variation and is lowered at night in shiftworkers, whilst Værnes *et al.* (1988) found levels of plasma immunoglobulins, an antibody found in body fluids, to negatively correlate with experience of work related stress in shiftworkers. Thus shiftworkers who suffer from stress as a result of work related difficulties had a less effective immune system. This led them to conclude that "psycho-social factors in the work environment may have a much greater impact on total health than previously accepted, affecting brain biochemistry, muscle metabolism, hormones and the immune system. This will influence almost all somatic disease known to man" (pp. 14).

2.4.5. Cancer

There is some evidence to suggest that shiftworkers, or those who work abnormal hours, may be at a greater risk of developing cancer. Welp (1998) found significant excesses of breast cancer amongst nurses and air cabin attendants, whilst Taylor *et al.*(1972) found that the rate of observed deaths from all types of cancer was significantly higher than the number of expected deaths from the disease in a group of shiftworkers. Rafnsson and Gunnarsdóttir (1990) carried out a retrospective cohort study on workers in a fertiliser plant in Iceland to assess the risk of stomach and lung cancer resulting from the ingestion of nitrates during production. As an indirect finding of their research they showed that those operators who worked shifts had the highest Standard Mortality Rates (SMR) for all cancers. Furthermore, shiftworkers showed a reverse dose response according to the length of their shiftwork experience, suggesting that increased risk in these individuals may have been due to factors unrelated to the manufacture of fertilisers, though they did not discuss what these 'factors' may be.

The mechanism of this increased risk is not fully understood but some researchers have suggested a link with the secretion of the pineal hormone 'melatonin'. It has long been established that both bright room light during the night shift and bright environmental light during the daytime has a major impact on the secretion of melatonin. According to Tamarkin *et al.* (1985) the relationship between shiftwork and cancer could theoretically be explained by the influence of nightwork on the production of the hormone, followed by a weakening of the immune system. In addition, melatonin has been shown to induce the constant production of prolactin and oestrogen, the total lifetime exposure of which has been related to the risk of breast cancer (Welp *et al.*, 1998). In contrast to this view however, Garland *et al.* (1990) compared the rates of breast cancer with the amount of solar radiation striking the ground in 87 areas of the US. They suggested that lower levels of light may lead to a higher prevalence of breast cancer after finding that women living in northern cities with a low level of winter daylight had a higher incidence of the disease.

Recent research has shown that the division of cancer cells which leads to the growth of tumours also has a circadian rhythm. For example, Klevecz and Barly (1987) analysed cells taken after surgery from the abdominal cavity of ovarian cancer patients in 2-4h intervals around the clock. Cancer cells typically reproduced at 12h frequencies with the peak most commonly occurring around 10:00 and 22:00. The fact that cancer cells may be affected by circadian rhythms is further supported by the increasing use of the chronobiological principle of timed drug delivery schedules. Such findings have clear implications for shiftworkers, suggesting that the circadian disruption of hormonal secretions and functioning of the body may lead to the development of chronic diseases such as cancer. Since shiftwork is known to result in circadian desynchronisation, it suggests that those who work abnormal hours may be at an increased risk compared to dayworkers.

2.4.6. Toxicological Effects

There is the suggestion that shiftwork may mediate the toxicological risk of certain substances in the work environment. This has been emphasised in findings from several animal studies showing a circadian pattern in the susceptibility to toxic substances such as mercurials, cyanides and organophosphates (Blackburn, Moffitt, White and Smolensky, 1980; Tai, Scheving and Pauly, 1982). Halberg (1989) showed that a fixed dose of poison killed virtually all mice that received it at one time of day but killed comparatively few, or even none, in those who received the same substance 12h later. Similar effects were also noted for loud noise and damage caused by X-rays.

These findings have been applied to humans where it has been shown that certain disorders such as asthma and epilepsy occur more frequently at one time of day than another (depending on a number of intervening variables) and that the effectiveness of certain medications can alter depending on the time of day at which they are administered. Whilst the medical profession typically prescribe medications to be taken in equal doses throughout the day, chrononbiologists argue that there is considerable variation over the day in the way in which the body absorbs, utilises and excretes drugs, as well as the interaction between different drugs. Hence the dose regimen should be matched to the circadian rhythmicity of the body to achieve the best effects and the least danger. Chronobiologists assert that medications should be prescribed according to the different needs and functions of the various biological systems being treated. For example, according to Costa (1996) if an hepatic enzyme's activity is essential to the detoxification of a specific substance, and the metabolic rate of the liver decreases during the night, the substance will take longer to be excreted than during the daytime, when the liver's metabolism increases. On the other hand, if a substance requires the metabolisation of the hepatic enzyme in order to become active, it will be dangerous during the daytime when metabolism is at its highest. This may help to explain why aspirin taken at 07:00 remains in the body for 24h compared with only 17h when taken at 19:00. Likewise antihistamine taken at 19:00 lasts for approximately 7-9 hours whilst the same dose taken at 07:00 lasts for between 15-17h (Lamberg, 1994). In a study of women suffering from advanced ovarian cancer, Hrushesky (1989) found that those women who took the first drug at 06:00 and then took the second drug twelve hours later, at 18:00, had fewer infections, incidences of bleeding and transfusions, less nausea, vomiting and adverse reactions to the medications, compared to those women who had taken the same dose of the drug but in reverse order. Perhaps most convincingly, 50% of those women who had fared better in the first instance had survived 5 years later, whilst only 11% of those on the less beneficial regimen had survived.

Likewise the detection of disease may hinge on the time of day at which diagnoses are performed. White blood cells are lowest in the morning and highest in the evening, whilst cortisol is abundant in the bloodstream in the early morning and extremely low around midnight. In this sense, the time of day at which an individual undergoes certain tests can determine their diagnosis. Such problems have obvious and dramatic implications for the health and well-being of individuals, especially shiftworkers, whose work schedules, by their very nature, affect the body's circadian rhythmicity, and therefore preclude them from the norm, putting them at an increased risk in terms of both the detection and treatment of medical disorders.

A matter that deserves far more attention than it has so far received are the problems that can arise when the shiftworker has been prescribed medications that need to be administered regularly, such as those for diabetes, affective disorders, contraceptive pills, or cardiac treatments. Little regard is given to those who work abnormal hours and yet have to interpret standard instructions. For example, does the nightworker told to take medication 'twice a day' assume that he should take them twice at night instead? Does the instruction 'to be taken at night' mean that he should take it in the morning before going to bed? Likewise for the diabetic strict monitoring of blood glucose may be made more difficult by the constant change in eating habits imposed by a rotating shift system. In a prospective study of 32 diabetics, Poole, Wright and Nattrass (1992) examined whether the control of diabetes was worse in insulin-dependant shiftworkers, and whether a change to a more rapidly rotating shift pattern would result in a deterioration of glycaemic control. Although the diabetic control of insulin dependant shiftworkers did not differ significantly from dayworkers, when the shift was changed from a slowly rotating, to a more rapidly rotating pattern, a significant deterioration of control was found. Furthermore, they noted that most subjects received no guidance from their GPs on how best to adjust their regimen to the new shift pattern, and that the main problem presented by the change in shift schedule was the reduction in the length of meal breaks.

In the light of such findings the tendency for shiftworkers to have higher incidences of health problems may be due to the fact that, although they are treated and prescribed in the same way as dayworkers, this does not take account of the circadian disruption resulting from shiftwork. Future research needs to examine whether the known TOD effects of certain substances, in addition to the known variations in biological activity, put shiftworkers at a disadvantage in terms of their health compared with those who work on a 9-5 basis, and to investigate the utility of circadian principles in the treatment and prevention of health outcomes in the shiftworking community.

2.4.7. Reproductive Health

Since the secretion of certain hormones is known to be controlled by circadian rhythms (Costa, Gaffuri, Ghirlanda, Minors and Waterhouse, 1995; Costa, Bertoldi, Kovacic, Ghirlanda, Minors and Waterhouse, 1997), is it not wholly unexpected that those systems which rely on hormonal activity may be affected by shiftwork. Indeed, there is evidence to suggest that the reproductive health of female shiftworkers, compared to non-shiftworkers, may be compromised, with a higher susceptibility in those women engaged in rotating shift patterns or those involved in nightwork (Colligan *et al.*, 1979). Such women have been found to be susceptible to reduced fertility and conception (Nurminen, 1995; Uehata and Sasakawa, 1982), increased risk of miscarriage (with nightwork being associated with a higher frequency of late spontaneous abortion) (Kolomodin-Hedman *et al.*, 1982; Uehata *et al.*, 1982; McDonald, McDonald, Armstrong, Cherry, Cote and Lavoie, 1988; Axelsson, Rylander, and Molin, 1989; Axelsson, Ahlborg, Bodin, 1996), stillbirth (Infante-Rivard, David, Gauthier and Rivard, 1993), elevated risk of low premature birth (Mamelle, Laumon and Lazar, 1984; McDonald, McDonald, Armstrong, Cherry, Nolin and Robert, 1988; Armstrong, Nolin and McDonald, 1989; Fortier, Marcoux and Brisson, 1995), intrauterine growth retardation, with an elevated risk of women giving birth to babies classed as small for their gestational age (Armstrong *et al.*, 1989; Nurminen, 1989) and heavy, painful or irregular menstruation (Tasto, Colligan, Skjei and Polly, 1978; Uhehata *et al.*, 1982; Pokorski, Iskra-Golec, Cezaj and Noworol, 1990; Messing, Saurel-Cubizolles, Bourgine and Kaminski, 1992). Although a recent study of the literature on the relationship between shiftwork and reproductive health by Nurminen (1998) stated that the evidence is "not ample and remains ambiguous", they nevertheless went on to conclude that "it is prudent to consider shiftwork as a potential risk to reproduction" (pp. 33). For a good review of the area, see Cox, Cox and Pryce (2000).

To the authors knowledge no such research has assessed the impact of shiftwork on the reproductive health of males, although there is reason to believe that they too may be affected. Sperm production has been shown to have a yearly rhythm, typically peaking in the spring and autumn, although the length of the day has been purported as the most important synchroniser in this respect. Levine (1990, cited in Lamberg, 1994) found that the semen quality of men was lower in summer than in the winter. Since heat is known to lower sperm counts, it was assumed that the heat of the summer was the cause of the problem. However, because there were no differences between those men who had worked outside in the heat and those who had worked in an air-conditioned environment, it suggests that the longer exposure to daylight during the summer months may be to blame. In the same way, the secretion of the male hormone testosterone also has a daily rhythm which varies seasonally, being highest in the early morning in May and early afternoon in November (a difference of more than 6h). The implications of such findings for male shiftworkers is that those who have a long exposure to light, such as nightworkers who are at home during the most intensive period of natural daylight and work under artificial light during their shift, may encounter more reproductive problems than male shiftworkers who have a normal exposure to light across the 24h period.

2.4.8. Affective Disorders

Several studies have shown that shiftwork, and especially that involving night duty, can also affect a worker's psychological health, leading to comparable symptoms by those who tolerate shiftwork poorly and those with affective disorders. These may include feelings of persistent fatigue, lethargy, anxiety, irritability, premature tiredness, nervousness, aggressive behaviour, sleep and appetite disturbances, inability to concentrate, changes in libido and changes in mood and depressive symptoms, many of which require treatment with sleeping pills and antidepressants (Thiis-Evensen, 1958; Aaonsen, 1964; Mott *et al.*, 1965; Hakkinen, 1969; Andersen, 1970; Koller *et al.*, 1978; Meers *et al.*, 1978; Costa, Apolisti, D'Andrea and Gaffuri, 1981; Koller, 1983; Reinberg, 1983; Gordon, Clearly, Parker and Czeisler, 1986; Cole, Loving and Kripke, 1990; Bohle and Tilley, 1993; Adeniran *et al.*, 1996). Psychological problems can often result in a vicious cycle of events feeding back into the shiftworkers' problems and becoming risk factors themselves in the aggravation of other psychosomatic complaints, as well as affecting relationships with family and friends (Repetti, 1989).

2.4.8.1. Mood

Many studies have confirmed TOD effects in relation to moods which may help to explain the association between shiftwork and altered mood states. For example, Prizmić, Vidaček, Radoševic-Vidaček, Kaliterna, Čabrajec-Grbac, Lalić and Fornazar-Knežević (1995) attempted to identify differences in 24h variations in moods in three groups of oil refinery workers:

tolerant, intolerant and non-shiftworkers. Intolerant workers showed higher levels of negative moods and lower levels of positive moods over 24h compared with the tolerant and non-shiftworking groups. However, the latter groups also had better sleep, less fatigue, and fewer psychosomatic digestive complaints, than the intolerant group, which would undoubtedly be reflected in their mood assessments.

Tasto *et al.* (1978) provided preliminary evidence that mood may be affected by the shift schedule itself. Using the 6 subscales of the Profile Of Mood States (POMS) they found elevated fatigue-inertia and confusion-bewilderment and diminished vigour-activity most clearly differentiated rotating and night nurses from the other groups. They also indicated that fatigue was higher in the intolerant group, as was the case with Prizmić *et al.* (1995). Wynne, Ryan and Cullen (1984) studied the short term impact of nightwork on moods and found the same three POMS dimensions mentioned by Tasto *et al.* (1978) to be primarily affected. They also found that the negative effects of nightwork on mood states were more pronounced on the first compared to the seventh night shift, suggesting that adaptation may result in better mood states. The effect of nightwork was also examined by Bohle and Tilley (1993) who investigated short-term changes in mood across several consecutive night shifts in a group of female student nurses. Using the POMS they found only the fatigue-inertia and vigour-activity subscales to be significantly affected (supporting Wynne *et al.*), although further analyses revealed that these changes were predominantly confined to the interval between the preceding rest day and the first night shift of the cycle. In a study of the effects of the compressed work week on the moods of shiftworkers, Rosa and Bonnett (1993) found decreases in self reported positive mood in subjects who had changed from an 8h to a 12h shift system. However, since these changes paralleled the reductions in sleep time across the compressed work week they suggested that sleep disturbance may be the root cause of such changes in affective state.

A different approach was taken by Dekker, Paley, Popkin and Tepas (1993) who studied the effects of caffeine on the moods of shiftworking train drivers. The principle behind this association was the conventional belief that shiftworkers consume large amounts of caffeinated drinks (Tepas and Mahan, 1989) in order to maintain alertness and, therefore, improve performance. However, the effects of even moderate amounts of caffeine may last for between 5-8h after ingestion and may delay sleep onset (Tepas, 1982) or cause sleep disturbance as a result of frequent awakenings to visit the bathroom. Impaired sleep may then give rise to negative mood states as an indirect influence of caffeine intake. Using daily logs, Dekker *et al.*, reported that coffee consumption was higher on work days and that sleep on work days was significantly shorter. Increased coffee consumption was correlated with increased sleep latency and negative mood, and decreased positive mood on both work and rest days.

2.4.8.2. Depression

According to Johnson, Weissman and Klerman (1992) depression in the workforce is a significant problem in most industrialised countries and is associated with, not only absence from work and social morbidity, but also the increased utilisation of healthcare services. Millar (1993) noted that the incidence of depression amongst the workforce has been steadily increasing since the early 1900's, whilst the age of onset has been steadily decreasing since the 1940's, estimating that, in today's occupational climate, 10% of workers can be expected to experience debilitating depressive symptoms. Recognition of this has resulted in the US National Institute for Occupational Safety and Health (NIOSH) including psychological disorders, encompassing depression, in its list of leading work related diseases and injuries.

Although the role of shiftwork in the prevalence of specific psychiatric disorders is still uncertain, several studies have found that both current and former shiftworkers report more symptoms characteristic of depressive illness (e.g., poor concentration, irritability, hopelessness, sensitivity to criticism, poor sleep) in comparison to dayworkers (Leuliet, 1963; Costa *et al.*, 1981; Michel-Briand, Chopard, Guiot, Paulmier, Struder and Struder, 1981; Koller, 1983) suggesting that shiftwork may predispose certain individuals to affective disorders. However, there is also evidence which contradicts this conclusion (Aanonsen, 1959; Taylor *et al.*, 1972; Angersbach, Knauth, Loskant, Karvonen, Undeutsch and Rutenfranz, 1980). This may, in part, be accounted for by the fact that the extent of psychological problems has been shown to depend on the shift schedule employed, with those causing the most disturbance to the shiftworker's routines resulting in the highest number of complaints. Thus according to the criteria used within the studies, different conclusions may be drawn. For example, in a study of 1200 nurses, Tasto *et al.* (1978) found that those on rotating shift schedules showed most signs of depression, followed by those on afternoon and night shifts. Nurses who worked day shifts showed the lowest levels of depression. Similar results were found by Jamal and Jamal (1982). Costa *et al.* (1981) reported a higher incidence of neurotic disorders (including depression) among permanent nightworkers (64.4%) followed by rotating 3-shift workers (22.1%) compared with dayworkers (3.9%) and 2-shift workers (9.4%).

The idea that difficulties with shiftwork arise gradually with shiftwork exposure (Haider *et al.*, 1988; Minors *et al.* 1994) was refuted by several authors studying affective complaints of first time nightworkers. Bohle and Tilley (1989) found increased psychological symptoms in nurses just starting shiftwork. Using a questionnaire specifically designed for the purpose, Healy, Minors and Waterhouse (1993) studied the effects of a first episode of nightwork on a group of 45 healthy nurses. They found highly significant increases in complaints of loss of energy, disturbed sleep, impaired appetite, poor concentration and loss of interest following a 3 month block of nightwork, in addition to an increase in the perceived level of criticism, and a decrease in the perceived level of support from others. Perhaps, not surprisingly, such symptoms led to greater feelings of helplessness and a rise in psychosomatic complaints. Adeniran *et al.*(1996) replicated the study with a further 55 nurses, with comparative results, noting that the increase in symptoms was such that a number of subjects would have met the criteria for a diagnosis of the 'melancholic' subtype of major depressive disorder.

The suggestion that shiftwork is related to depression stems from evidence showing a link between circadian desynchronisation and depressive symptomatology. Symptomatic, depressed patients have been shown to have circadian rhythms that are reduced in amplitude and characterised by phase changes resulting in early awakenings (David, Maclean, Knowles and Coulter, 1991), a major symptom of depression, whilst Frank, Kupfer, Ehlers, Monk and Cornes (1995) found time zone changes or a night of sleep deprivation to be the common precursors to incidences of mania in bipolar depressives. Such suggestions have been further supported by Jauhar and Weller (1983, cited in Scott, Monk, Luann and Brink, 1997) in a review of psychiatric incidents at Heathrow Airport, who found a directional relationship between circadian disruption and the type of affective disorder experienced. After eastbound flights that induced a phase advance, there was a propensity for mania, whilst a phase delay resulting from westbound travel was characterised by a preponderance of depression.

That there may be a link between circadian rhythmicity and depression is demonstrated by the use of both sleep and light therapy as treatment regimens. Ford and Kamerov (1989, cited in Lambert, 1994) found that those people who had complained of insufficient sleep and feeling sleepy during the day were those who, when surveyed again one year later, were more likely to have developed severe depression or anxiety disorder. In line with this Ohayon *et al.* (1997) found depressive disorder (based on DSM-IV) to be associated with excessive daytime sleepiness.

Light therapy is an alternative treatment for depression (see Chesson, Littner, Davila, Anderson, Grigg-Damberger, Hartse, Johnson and Wise, 1999, for a review), especially Seasonal Affective Disorder (SAD), which for the majority of cases brings about depressive symptoms during the winter, when the amount of sunlight is severely reduced. The first to demonstrate the efficacy of phototherapy in SAD, Rosenthal and Howe (1984) found that when sufferers were positioned in front of bright fluorescent lights, equivalent in strength to daylight just after sunrise, their symptoms were alleviated. Whilst the treatment has undergone a number of improvements, daily exposure to artificial bright light via the 'light box' remains the most popular treatment for so-called 'winter depression'. Such findings suggest that if exposure to light can reverse the symptoms of depression then the lack of light may increase depressive symptomatology. When this is applied to shiftworkers, especially nightworkers who sleep during the day and work during the night, it suggests a possible mechanism to explain the prevalence and treatment of depression in this group.

Others have taken a more psycho-social approach and argue that the social and family disruption caused by shiftwork are also important in the development of depression. In their conceptual model of depression in shiftworkers, Scott *et al.* (1997) argue that the shiftworker is presented with three major demands: biological, social/domestic and work/rest schedule, which combine to affect the level of circadian disruption and sleep loss and, in the long-term, the level of shiftwork related stress. In this way, the workers' depressive predisposition will be determined by both the level of stress and the level of circadian disruption, although personal characteristics such as the length of shiftwork exposure and the occurrence of negative life events (e.g., divorce and bereavement) are also highlighted. Depending on the combination of these factors, Scott *et al.* posit 4 possible outcomes, ranging from no symptoms to major depressive disorder.

In order to test this model Scott *et al.* administered two standardised psychiatric assessment instruments (the SCID to determine lifetime incidence and the CES-D to evaluate current depressive symptoms) to former and current shiftworkers. Their findings showed a 15% rate of DSM-IIIR major depressive disorder (MDD) occurring during or after shiftwork for all subjects. An episode of MDD occurring during shiftwork was found to have occurred in 14.3% of those currently employed on shifts, whilst the prevalence in former shiftworkers, during or after shiftwork, was 15.7%. Shiftwork exposure was found to increase the prevalence of MDD, with a dramatic drop observed in those who had 20 years or more experience. Interestingly, when the two groups were combined, females were found to have a higher prevalence than males, (22.6% compared to 13.4% respectively) suggesting an additional vulnerability factor of gender. Scott *et al.* concluded that "the results provide suggestive evidence that shiftwork can induce depression in vulnerable individuals" (pp. 7).

Bringing the findings of past research together, Skipper, Jung and Coffey (1990) attempted to examine two alternative models of the relationship between shiftwork and depression. In the first, circadian disruption, model they argued that shiftwork disturbs the circadian rhythmicity of the body which in turn influences both the physical and mental health of workers. This then leads onto problems with family and social life, job performance and job related stress. Thus according to this model depression contributes to the employee's work and non-work problems as a result of working shifts. In the second, psycho-social model, shiftwork is posited to affect the social and work-related variables of the individual, in turn affecting their physical health and state of depression. However, using 482 female nurses from 5 different hospitals, Skipper *et al.* failed to find any supportive evidence for either model, with all correlations between physical health, depression and shiftwork being weak or non-existent. Only the association between shiftwork and sleep was significant. In summing up their findings the authors noted that several weaknesses in the design of their study may have led to the models being rejected. Firstly, they noted that since they had used day, afternoon, night and rotating nurses, the work tasks and job requirements on each shift type may have differed and exerted a moderating influence upon the negative effects usually associated with shiftwork. They also acknowledged that the dayworking group may have contained a number of former shiftworkers who had transferred to days due to difficulties adapting to shiftwork. They also raised the criticism that shiftwork research too often produces negative bias, not considering the possible positive effects of shiftwork for some individuals who use their work schedule as a way of dealing with their responsibilities, and who actually enjoy working shifts.

Thus whilst previous research has not resolved the question of causality in terms of which of the two models best describe the relationship between shiftwork and depression, it does nevertheless, highlight several important variables that need to be taken into account in future research. As is the case throughout shiftwork research it must be remembered that the shiftworker's problems are often a combination of work, home and personal conflicts, all of which need to be examined in more detail. Regardless of the mechanisms involved, some have suggested that the generation and maintenance of routines, both circadian and psycho-social, are themselves an effective antidepressant. Thus future research needs to explore which routines in particular benefit the shiftworker to a greatest extent, a question that has major implications for replacing conventional psychotropic drugs with less harmful, and perhaps more appropriate, methods of treatment.

2.4.9. Cardiovascular Complaints

Coronary Heart Disease (CHD) is one of the major causes of death in modern industrialised societies and one which often kills prematurely or leaves its victims with a reduced quality of life. Not surprisingly extensive research has concentrated on investigating the factors which put individuals at risk. Shiftwork has been nominated as one such factor. Some sources have estimated that the cost of cardiovascular disease (CVD) in this sector may be as much as $40 billion (National Health Care Financing Review, 1998), making shiftwork one of the major work environmental factors related to CVD (Åkerstedt and Knutsson, 1997). Indeed, one line of research linking work to coronary problems is the Japanese phenomenon of 'karoshi' (quite literally translated as "death from overwork"), in which long working hours have been associated with a number of deaths from coronary disorders.

The degree of association between shiftwork and cardiovascular disorders remains controversial with some finding an increased risk in shiftworkers compared to dayworkers (Pierach and Heynemann, 1955; Koller *et al.*, 1978) and others finding no difference (Angersbach *et al.*, 1980). As time has progressed and interest in the area has become more pronounced the conclusions as to the extent of the risk have altered. In a review of the health effects of shiftwork by Harrington (1978) the general conclusion had been that there was "no firm evidence that CVD is more prevalent in shiftworkers" (pp. 12). Indeed, some large-scale epidemiological studies of morbidity, absenteeism and mortality failed to find significant differences between shiftworkers and dayworkers in terms of CVD. For example, Aanonsen (1959) found dayworkers to have 10% more absence attributable to CHD compared with shiftworkers. In support of this, Taylor and Pocock (1972) showed the longest proportional excess of absence due to heart problems in dayworkers. However, they did note a slight excess of mortality in shiftworkers, especially former shiftworkers, compared with dayworkers, although the difference was not significant. In an update of Harrington's review, Waterhouse, Folkard and Minors (1992) noted that an increasing number of papers published since 1978 had been more likely to report increased CHD in shiftworkers, and moreso in those who had dropped out (Angersbach *et al.*, 1980). As a result of their findings, Waterhouse *et al.* stated that the evidence in favour of shiftwork being associated with CVD was "becoming more difficult to dismiss as inconclusive" (pp. 20). In an about turn of his earlier closing statements, a later review of the literature in 1993, found Harrington stating that "based on the current evidence, the case for a link between cardiovascular disease and hours of work is strong enough to give serious consideration" (pp. 17). This was later supported by Folkard (1994) in a critique of Harrington's review.

The main findings on the subject have shown (i) a higher prevalence of cardiovascular disorders amongst shiftworkers, and particularly former shiftworkers, in comparison to dayworkers (Frese and Semmer, 1986; Kristensen, 1989; Waterhouse *et al.*, 1992); (ii) a prevalence of angina pectoris and hypertension among shiftworkers (Michel-Briand *et al.*, 1981; Zahorska-Markiewicz, Kutagowska, Bogunia and Wegrzyn-Radecka, 1990); (iii) acceleration of age related decline of pulmonary function, at least in elderly shiftworkers (Gangopadhyay, Chandrawanshi and Pati, 1989); (iv) a higher morbidity for cardiocirculatory and ischaemic heart disease with increasing age and exposure to shiftwork (Koller, 1983; Knutsson *et al.*, 1986); (v) an increased relative risk of myocardial infarction in occupations with high proportions of shiftworkers (Alfredsson, Karasek and Theorell, 1982); and (vi) alterations in lipid metabolism in shiftworkers, particularly higher levels of cholesterol and triglycerides (Orth-Gomer, 1983; Romon, Graibaud, Nuttens, Fievet, Bar, Pot and Furon, 1990).

Despite the renewed interest in the link between shiftwork and cardiovascular complaints there is still debate as to whether the mechanism underlying this association is a direct result of the disturbance of the circadian rhythms, and hence the increased stress associated with shiftwork (Orth-Gomer, 1983), or whether it is an indirect consequence of certain well established risk factors which are more prevalent in shiftworkers. In support of the circadian disruption principle, Ely and Mostardi (1986) showed that police officers who worked on rotating shifts had higher levels of noradrenaline, which in their opinion, if uncontrolled, could lead to increased cardiovascular risk. In a longitudinal study of shiftworking policemen, Orth-Gomer (1983) found that when the shift rotated clockwise (causing a phase delay), systolic blood pressure and levels of urinary catecholamines were reliably lower, in comparison to an anti-clockwise, or advancing, shift rotation. Whilst the study did not rule out the influence of other risk factors, such as age and exposure to shiftwork, they concluded that adapting the shift rotation in line with the biological rhythms of the individual may reduce the risk of ischaemic heart disease. In support of this, Steenland and Fine (1996) investigated whether a recent change in shift schedule may be a risk factor. They found that a recent change from night or afternoon shifts to day shifts had a protective effect initially, but this decreased over time. Furthermore, at the time of death 72% of shiftworkers studied had been working the first shift, 22% the second and 6% the third, suggesting that disruption of circadian routines may lead to an increased risk of mortality.

This circadian approach has also been investigated with regard to the well established sleep disturbances which occur in shiftworkers. Lavie *et al.* (1989) found that those shiftworkers who complained of sleep disturbances had a higher incidence of hypertension and higher levels of blood pressure (particularly diastolic) in comparison to both non-complainers and dayworkers. Such findings are particularly interesting since the effects of age, body weight and smoking habits were controlled for. Likewise, in a cohort study designed to evaluate risk factors for CVD, Newman, Spieckerman, Enright, Lefkowitz, Manolio, Reynolds and Robbins (2000) found daytime sleepiness to be the only sleep disturbance associated with mortality and morbidity from CHD, myocardial infarction and congestive heart failure. Peacock, Glube, Miller and Clune (1983) found that when police officers changed from an 8h to a 12h shift system both their sleep quality and sleep duration improved, as did their cardiorespiratory fitness and blood pressure readings.

Indirect influences have also been examined with regard to the pathogenesis of cardiovascular problems in shiftworkers. These are factors which play an important role in conditioning the risk for CVD and have included unfavourable living conditions, poor diet, disturbed sleep, age, exposure to shiftwork, and alcohol, nicotine and caffeine consumption (Buell and Elliot, 1980). In terms of exposure, Koller (1983) found that the longer workers had spent in shiftwork, the more frequently they suffered from circulatory disease. In a 15 year study that controlled for factors such as age and smoking, Knutsson *et al.* (1986) reported the relative risk for heart disease among shiftworkers at a paper mill as being 2.2 for an exposure of 11-15 years of work rising to 2.8 for an exposure of 16-20 years, and that after age, exposure to shiftwork was the main predictor of CVD. Astonishing similarities were found in a carefully controlled study by Coburn (1996) who reported that the risk of coronary artery disease after 5 years exposure to shiftwork was 5 times higher than the general population, 2.2 times as great after 10 years and 2.8 times as great after 15 years of shiftwork. Although McNamee, Binks, Jones, Faulkner, Slovak and Cherry (1996) found no relation between the risk of death from ischaemic heart disease and duration of shiftwork experience, they did find evidence of a reduced risk when actively employed as a shiftworker, together with an increased risk in the first 5 years after leaving shiftwork. This led them to conclude that the rate of death from cardiovascular complaints may be underrepresented due to the healthy shiftworker effect. Another related risk factor to exposure is age. It is well known that certain complaints are more prevalent in older individuals and therefore it may be the case that the rise in CVD with exposure to shiftwork may be a result of age, rather than an accumulation of the effects of shiftwork over a number of years.

Smoking is notoriously known to be a risk factor for CVD in the general population (Keys, 1967; Astrup and Kjeldsen, 1974; Havlik and Feinlab, 1979; Buell *et al.*, 1980) since it raises the levels of lipids in the bloodstream, and can increase the risk of heart problems. However, despite its relevance in helping to explain the pathway from shiftwork to cardiovascular problems, it has received scant attention in the literature. This, in part, may be due to the inconsistent findings and weaknesses in the methodologies of those that have found similar results. For example, whilst some have reported a higher proportion of smokers in the shiftworking population (Thelle, Forde, Try and Lehmann, 1976; Knutsson, Åkerstedt and Jonsson, 1988; Mensch and Kandel, 1988; Green and Johnson, 1990), none had reported the specifics of smoking behaviour (i.e., the quantity or type of cigarettes consumed or the duration of smoking). Thelle *et al.*(1976) failed to report the level of significance and Knutsson *et al.* (1988) concluded that the difference did not account for the higher incidence of CVD amongst the shiftworking cohort. To further add to this confusion, additional studies have reported no difference between the smoking habits of shiftworkers and dayworkers. A recent study by

Nikolova, Vassileva, Handijex, Angelova and Saradjova (2000) found no significant differences in the smoking habits of shiftworking and dayworking air traffic controllers, although 61% of the former were smokers compared with 55% in the latter.

Despite the conflicting findings, Knutsson *et al.* (1988) discussed several possible reasons to explain why shiftworkers show increased levels of smoking. Using evidence showing smoking to be more prevalent in those of low socio-economic status and low education (Covey and Wynder, 1981; Cummings, Shaper, Walker and Wale, 1981; Haye and Foster, 1981) they argued that smokers may prefer shiftwork, and this preference could operate through such confounding variables as socio-economic status or marital status. In other words, there may be a selection of smokers into shiftwork. This argument was dismissed after they noted that those shift and dayworkers included in the study had come from very similar living conditions and economic backgrounds, and in fact shiftworkers tended to earn more than dayworkers. According to this theory this should have resulted in a lower prevalence of smoking in the former. Work conditions were also discussed, however again they noted that both shift and dayworkers had similar work environments and tasks. They concluded that the most likely explanation for the difference in smoking behaviour was the organisation of work hours, in that shiftworkers may be more likely to use smoking as a means of staying alert or to pass the time during long work hours. Although such suggestions are only speculative more extensive research is required in order to evaluate the true impact of smoking as a risk factor for CVD. Such work also needs to assess whether shiftworkers are more prevalent smokers and if so, to investigate the intervening variables underlying such behaviour.

There is also evidence to suggest that heart problems may be mediated by nutritional disturbances consequent on shiftwork, as investigated by Handijex (1990). After measuring the body weight and relative body mass, in addition to examining the nutritional habits of 1276 night and shift transport workers, the author reported that 63.6% of those tested had serious anthropometric and metabolic risk factors. In discussing these findings Handijex noted that the combined effects of shiftwork and various types of work strain destroyed the balance of the metabolic processes, and in particular increased the consumption of fats (which can lead to hypercholesterolaemia, hypertriglyceridaemia, obesity, hypertension and ischaemic heart disease). Indeed, Handijex mentions that diets that reduce such metabolic disorders and, therefore, coronary complaints, reduce the amount of fats and carbohydrates consumed and enrich the diet with pectin, fibre, fruits and vegetables. Physical exercise was also identified as a key part in this process. We will deal with the effects of shiftwork on eating behaviour and diet in full later in this chapter.

Obvious, yet little studied, candidates linking shiftwork and CHD are psycho-social factors, particularly the stress resulting from the work/non-work conflict so often mentioned in shiftwork research. Despite the paucity of research in this area, stress is an extremely important factor in this respect having the capacity to link both circadian and traditional risk factors together. Rutenfranz, Knauth and Angersbach (1981) developed the stress-strain model to explain the problems experienced by shiftworkers. In this model stress is seen as resulting from the phase shifting of the worker's sleep-wake cycle in relation to the normal circadian rhythms of physiological and psychological functions. Such effects lead to subjective strain which can affect the shiftworker's working efficiency, family and social life, and impaired health and well-being. However, the individual is not seen as a passive component in this relationship. Instead the degree of strain is influenced by a number of intervening variables acting separately or in combination. These include (i) individual characteristics, such as age, gender, personality, circadian type and physiological adaptability; (ii) work conditions, such as the workload, length of shift, type of shift and environmental conditions; and (iii) social and domestic factors such as housing conditions, socio-economic status, number of children and marital status. Although it is not mentioned in the model, it seems unlikely that the shiftworker will passively accept this strain but instead will typically try to actively counteract the stress by initiating coping strategies. The success of such strategies will ultimately depend on the worker's coping resources and the types of strategy employed, although in some cases, such as the consumption of nicotine to induce a state of alertness, attempts to adapt may actually increase the risk of developing CHD.

In support of such a model Theorell (1984) reported that life changes requiring a change in routine effectively doubled in the three months prior to the occurrence of ischaemic heart disease. Jenkins (1976) reported that stressors, such as overload at work and chronic conflict, were implicated as risk factors for CHD. Moreover, Alfreddsson *et al.* (1982) investigated the psychosocial characteristics of different occupational groups in relation to the incidence of myocardial infarction and found shiftwork to be associated with significant excess risk.

There is substantial evidence to date showing that increased psycho-social stress and life changes, the typical side effects of shiftwork, can elevate blood pressure (Harburg, Schull, Erfurt and Schork, 1970; Rahe, Bennett, Romo, Siltanen, and Arthur, 1973; Shapiro, 1978; Weiner, 1979; Engel, Muller, Munch and Ackenheil, 1980) through sympathetic activation (Kaplan, 1978). This same activation then causes an increase in noradrenaline which leads to an increased heart rate and hypertension, a known precursor to CHD. In support of such evidence, Alfredsson, Knutsson, Siegrist and Westerholm (1999) found that a stressful psychosocial work environment acts as a mediator of the adverse health effects of shiftwork on hypertension and, partly, atherogenic lipids. Ely, Richard and Mostardi (1986) found that rotating shiftworkers had a higher number of life changes (130; according to the Holmes and Rahe Schedule of Recent Life Changes) compared with both night (103), and day (106) workers. Rotating shiftworkers also had significantly elevated levels of norepinephrine and the highest diastolic blood pressure of the three groups. Such findings have enormous implications for those working on, what some would term, more stressful schedules, such as those involving long hours, working at times that are valued for leisure, or those which prevent adjustment (e.g., slowly rotating schedules). Also if evidence from the double burden in women is anything to go by then, in particular that women with domestic responsibilities have been shown to have impaired sleep and social lives, it suggests that women who find themselves in such situations should be at a higher risk of developing CHD in comparison to their male counterparts.

Gender differences were examined by Alfredsson, Spetz and Theorell (1985) who related the occupation of around 600,000 working men and 400,000 working women to the risk of being hospitalised for myocardial infarction during a follow up period of 1 year. Although they found that shiftwork was associated with increased risk in both genders, a number of differences were also reported. In occupations where overtime work was common, women showed a higher risk, whilst in men such extra hours were associated with protection against risk. In contrast, men in occupations that were characterised as being 'nonlearning' and 'hectic' clearly had higher incidences of hospitalisation, (not at all significant for women). Such a finding supports the hypothesis of Karasek (1979) that a job characterised by high demand and low decision latitude is a particularly dangerous combination in inducing job strain. In a similar study, Theorell, Ahlberg, Huttén, Berggren, Perski, Sigala, Svensson and Wallin (1987, cited in Theorell, 1991) found that low decision latitude was associated with high blood pressure in both males and females. However they did note that women tended to show very little difference in systolic blood pressure at work and during leisure, suggesting that difficulty in combining work and household duties may have caused unusual arousal in these women.

If job related stressors which affect health, and particularly the risk of developing CHD, can be identified, employers will be better able to moderate the work environment in order to reduce or eliminate such stress, whilst employees can be educated in ways to cope with the conflicts that may arise as a result of their work pattern. After all, such measures should provide reciprocal benefit since a healthy workforce will not only decrease absenteeism, but should also increase job satisfaction and productivity.

In conclusion, although comparison of the findings is made difficult by the fact that the studies in this area differ widely in the methodologies and shiftworker populations used, in terms of occupational health, the findings call for a more comprehensive assessment of the health risks associated with shiftwork, in order to gain a better understanding of how they may mediate the impact of shiftwork upon CVD. Even the best predictive equations combining established risk factors often leave the aetiology of CVD unexplained, and it is now becoming ever clearer from the conflicting and overlapping evidence that cardiovascular complaints are multifactorial. Future research needs to take a more multi-directional approach, assessing the relative impact of risk factors and how they may interact to affect the risk of developing disease. Whilst some may argue that this is a complex process and one which, by its very nature, will be time consuming and expensive, one only has to realise the sheer number of people who, either knowingly or unknowingly, are at risk from CHD to recognise the benefit of this knowledge in preventing a disease which at best is debilitating and at worst fatal.

2.4.10. Gastrointestinal Complaints

After sleep problems, complaints pertaining to gastrointestinal (GI) function are the most frequently recorded amongst shiftworkers. As far back as 1921, Vernon recorded numerous cases of stomach disorders among the shiftworkers of armament factories. In an extensive review of 36 epidemiological studies carried out over the last 50 years, involving 98,000 workers from various work sectors, Rutenfranz (1982) estimated that between 20-75% of shiftworkers involved in nightwork, in comparison to only 10-25% of dayworkers and shiftworkers without nightwork, complain of disturbances of appetite, irregular bowel movements with prevalent constipation, dyspepsia, heartburn, abdominal pains and flatulence. Many workers may also develop chronic disease such as chronic gastritis, gastroduodenitis and peptic ulcer. Harrington (1978) concluded that there was "a balance of good epidemiological evidence linking gastrointestinal disorders, particularly gastric and duodenal ulcers, with shiftwork" (pp. 19) whilst the later review of this work concluded that "further studies have tended to push the balance further to the disadvantage of shiftworkers" (Waterhouse *et al.*, 1992, pp.4).

One of the most extensively studied GI complaints is that of duodenal and peptic ulcers. Early studies, such as Duesberg and Weiss (1939) and Brusgaard (1949) estimated that those working shifts were 8 times more likely to develop peptic ulcers. Recent studies are more conservative, estimating the risk to be between 2 (Angersbach *et al.*, 1980) and 5 (Costa *et al.*, 1981) times higher in shiftworkers involved in nightwork compared to both dayworkers and shiftworkers without nights. Furthermore, Costa *et al.* (1981) reported that the average interval between the start of work and diagnosis of a peptic ulcer was significantly shorter amongst shiftworkers who worked nights as part of their schedule. Whilst the longest interval was observed amongst 2-shiftworkers without nightwork (14.4 years), followed by dayworkers (12.2 years), it was comparatively lower in permanent nightworkers (5.6 years) and rotating 3-shiftworkers (5 years).

In reviewing the findings on GI complaints, both Rutenfranz (1981) and Costa (1996) noted a striking overlap in the incidence of GI disorders amongst shiftworkers and non-shiftworkers. A number of epidemiological studies report a higher prevalence amongst shiftworkers (Duesberg *et al.*, 1939; Brusgaard, 1949; Aanonsen, 1959; Angersbach *et al.*, 1980; Segawa *et al.*, 1987), some have found the opposite (Jacquis, 1963; Leuliet, 1963 cited in Costa, 1996), whilst a number have reported no difference (Gaulthier, Housset, and Martin, 1961; Mott *et al.*, 1965; Taylor, 1967; Michel-Briand *et al.*, 1981). A possible cause of such inconsistency is the huge array of methodology employed (ranging from questionnaires and interviews through to indirect medical reports and direct medical examinations), the characteristics of the populations investigated (work sector, number of participants, age, length of shiftwork experience, shift type, job type), and the study design (retrospective, cross sectional, cohort).

An alternative explanation is the oft-mentioned healthy shiftworker effect, often admitted by the authors themselves. A number of studies have shown that those who have left shiftwork report the greatest number of GI complaints (Bjerner, Holm and Swennsen, 1955; Angersbach *et al.*, 1980), suggesting that peptic ulcers are between 2 (Thiis-Evensen, 1958; Aanonsen, 1964) and 3½ (Angersbach *et al.*, 1980) times as frequent amongst previous regular shiftworkers who have transferred to daywork. Conventional methodologies do little to aid this problem, for whilst cross-sectional studies do not consider the proportion of workers who may have left shiftwork, participants involved in longitudinal studies (almost exclusively retrospective in these cases) are notoriously difficult to follow up. Over the 12 year period that the investigation by Leuliet (1963) took place, the original sample had almost halved in size, whilst, in a retrospective cohort study, Angersbach *et al.* (1980) noted that 210 of 370 shiftworkers and 142 of 270 dayworkers remained on their original hours of work after an 11 year period.

Despite the general agreement that shiftwork is bad for the stomach there is no consensus as to the mechanisms responsible, although irregular hours, meals, nicotine and alcohol consumption, stress, sleep and workload have been evoked as underlying causes. A number of studies, animal and human, have shown circadian rhythmicity in both the secretion and control of digestive acids and motility, leading to the suggestion that the desynchronisation consequent on working shifts is a primary reason. The observation of a circadian pattern in human gastric acidity was first reported by Levin, Kirsner and Palmer (1952) and subsequent research has demonstrated a peak during the day and early evening with a concomitant early morning trough (Feurle, Ketterer, Becker and Creutzfeldt, 1972; Ganguli and Forrester, 1972; Moore *et al.*, 1970, 1973a, 1973b, 1974, 1987 cited in Moore, 1988). Likewise Frienkel, Mager and Vinnick (1968) and Malherbe, de Gasparo, de Hertogh and Hoet (1969) showed that insulin levels in plasma were significantly higher in the morning and lower in the evening. The mechanism underlying this rhythmicity is unknown, although Moore and Wolfe (1974) argued that the circadian rhythm of plasma gastrin resulted from the stimulation of food on the gastrin producing cells, after finding that the rhythm disappeared when subjects were fasted.

In reviewing evidence on the chronobiology of gastric function, Moore (1988) presented a theory of ulcerogenesis which proposed that GI ulcers could result from an imbalance between aggressive (i.e. gastric acid) and protective (i.e. blood flow, mucosal bicarbonate production) factors. According to Moore, in normal circumstances the protective factors parallel and always exceed the aggressive factors throughout the circadian cycle, but if these two components desynchronise, as may be the case in those working shifts, the aggressive factors may exceed the ability of the gastric mucosa to resist injury, creating an ulcerogenic potential. Moore argues that a phase shifting of the circadian rhythms means that for ½ of the 24h period, there will be an ulcerogenic potential whilst for the other ½ there will be a predominance of protective mucosa. In this way, an absolute increase or decrease of the two components is not required to produce risk. Such a model has been supported by evidence from clinical observations showing extraordinarily high healing rates for a single night-time dose of a gastric acid blocker, compared to a twice daily regimen of the same drug (Colin-Jones *et al.*, 1984 cited in Moore, 1988). Circadian rhythmicity has also been implicated in gastric motility. Moore (no date given, cited in Rubin, 1988) measured gastric emptying in 16 healthy male subjects and found that it emptied significantly more slowly after the evening meal than an identical meal consumed in the morning. That shiftwork related GI disorders can be explained by the circadian theory has been confirmed by studies that have found a higher prevalence of ulcers amongst workers who had more difficulty in adjusting their rhythmic functions (Mott *et al.*, 1965) and a higher number of complaints amongst those working the night or rotating shifts, assumed to cause the most circadian disruption, compared with dayworkers and shiftworkers not working nights (Rutenfranz, 1981).

An alternative explanation for the higher prevalence of GI disorders in shiftworkers is perturbation of mealtimes and particularly irregularity and composition of the meals eaten. Mealtimes act as an important zeitgeber but are typically altered to fit in with the constraints of the shift system worked. For example, those working an early morning shift may omit breakfast in favour of an extra hour or so in bed but will eat lunch and dinner at the normal times. In contrast the eating patterns of the nightworker need to be inverted to fit in with their sleep-wake cycle, but, as will be discussed in the proceeding section, this often is not the case. Composition of meals can also be radically altered. Meals can lose their individuality and convenience foods, often cold or fried, become more frequent components of the diet. For the nightworker the main evening meal actually occurs at around 01:00 in the morning, a time at which many may not have an appetite for the usual evening meal foods. Furthermore there remains some debate as to whether the composition of this meal should reflect a late main meal or an early breakfast. Of course this would depend on the shift type worked. For the permanent nightworker attempting to establish a long term routine, it may be more beneficial to treat this mealtime as 'dinner' whilst for the worker on a rotating schedule it may be more advantageous in terms of circadian adaptation, to treat the meal as 'breakfast', since it would fit in better with the meal routines during morning and afternoon shifts. Ultimately, one must bear in mind that the stomach is simply not able to cope as well with digestion during the early hours of the morning and, therefore, any foods consumed during this time need to be easily digestible.

Angersbach *et al.* (1980) examined the role of confounding factors in the link between shiftwork and GI complaints. They found that at the first medical examination 77 of the 370 shiftworkers and 22 of the 270 dayworkers reported a past history of GI diseases, although at this time nobody reported peptic ulcers. In the intervening 11 years, both shiftworkers and dayworkers with past history of GI diseases had distinctly more absences per man a year than those who had reported no problems at the preliminary check up. Furthermore, these differences between the cohorts were pronounced within the first 2 years of beginning their respective work schedules. Age also affected the incidence of GI complaints, morbidity decreasing with increasing age, with the main finding being a higher preponderance amongst shiftworkers compared to dayworkers between the ages of 21 and 50, but no difference in the group aged 51-64, a finding supported in a number of other studies (Thiis-Evensen, 1949; Wade, 1955). Contradictory evidence has also been cited (Bjerner *et al.*, 1948; Dahlman, 1953). Furthermore, unmarried shiftworkers also had more absence days due to GI disease during the first 3 years of work, whereas within dayworkers no difference according to marital status was reported.

Exacerbation of GI problems through smoking has received little attention, but evidence showing a higher percentage of GI disease amongst shiftworkers who smoke, especially those smoking over 10 cigarettes per day, suggests a possible link (Friedman, Siegalaub and Seltzer, 1974; Paffenbarger, Wing, and Hyde, 1974). Angersbach *et al.* (1980) reported a significantly higher proportion of problems in shiftworkers who smoked more than 10 cigarettes a day (60%) compared with non-smokers (48%), and suggested that given the high percentage of smokers within the shiftworking cohort, shiftwork may cause a specific pattern of behaviour which then influences the level of GI problems, as suggested by Knutsson *et al.* (1988) in line with CHD.

Wolf *et al.* (1979), reviewing the role of stress in peptic ulcer disease, argued that although there are several factors which may predict increased likelihood of developing duodenal ulcers, none were job related, suggesting that nightwork may only be a minor risk factor. Therefore, shiftwork may have an indirect influence on GI health since it not only stresses the gut through perturbation of the eating cycle and the desynchronisation of digestive rhythmicity but also through the strains that result from poor sleep, impoverished social and family life and impaired general health and well-being. Not only can shiftwork increase the risk of developing GI disorders, but can also aggravate existing ulcers and interfere with good ulcer management. In this way variables such as genetic make-up and family history, in addition to dietary preferences and social conditions, must all be included in the equation.

A number of authors have concluded that many of the inconsistencies found in research into GI complaints in shiftwork is due to the fact that complaints of the GI tract are not monocausal and can be affected by myriad factors working separately or in combination. Therefore, it is unlikely that a single factor will be found to be responsible for the difficulties observed. After all, GI complaints are very common amongst the general population and therefore the role that shiftwork plays in exacerbating these underlying risks is essential in the prevention of GI complaints in, what some have estimated as being, 30-50% of shiftworkers (Waterhouse *et al.*, 1992).

2.5. Eating Behaviour and Diet

"One cannot think well, love well, sleep well, if one has not dined well"
Virginia Woolf: *A Room of One's Own (1929)*

It is well established that the amounts, composition and distribution of food intake can affect general health (Armstrong, 1980; Adams and Morgan, 1981; WHO, 1990). Indeed, one study using non-shiftwork cohorts posited meal frequency as a possible factor in the pathology of obesity, hypercholesterolaemia, impaired glucose tolerance and ischaemic heart disease (Fabry and Tepperman, 1970). Yet despite the importance of such evidence astonishingly few studies to date have examined the dietary habits among shiftworkers with special emphasis on diet and health problems. Those which do exist are generally inconclusive.

It is likely that improper nutritional hygiene, brought on by the desynchronisation of the circadian cycle or by the demands of working irregular hours, is at least in part responsible for the GI problems observed in shiftworkers (Rutenfranz, 1981). According to Folkard, Minors and Waterhouse (1985) disturbances of appetite are particularly prevalent at night (Takagi, 1972; Duchon and Keran, 1990) and are probably caused by the temporal structuring of work, the sequencing of meals, and the disruption of sleep. They also note that shiftworkers typically retain their normal eating habits regardless of the shift schedule and during days off. So whilst certain shift systems, especially those involving nightwork can cause an inversion of many of the bodily rhythms, the nutritional cycle does not tend to show such an inversion. Wyatt and Marriot (1953) found that 74% of men on a 2-shift rotating pattern complained of loss of appetite on the night shift which they attributed to 'unnatural mealtimes'. More recently Cervinka, Kundi, Koller, Haider and Arnhof (1984) studied the eating patterns of rotating shiftworkers and found that 2 consecutive night shifts were not associated with an inversion of the normal daytime eating behaviour, although they did note that the usual sharp peaks of eating times tended to flatten out by the second night shift. Rutenfranz (1981) found that significantly more rotating shiftworkers and permanent nightworkers complained of disturbed appetite compared to those working days. In a study of eating patterns and satisfaction with eating habits, Tasto *et al.* (1978) reported that the eating patterns of rotating shiftworkers tended to differ according to the shift type worked, permanent workers exhibiting more consistent behaviour. Disappointingly, analysis of what these 'different eating patterns' were within each shift was not conducted.

Fortunately, others *have* analysed the eating patterns within each shift. In a study of Japanese shiftworkers on rotating shifts, Takagi (1972) found that the number of meals consumed decreased when working the night shift compared with the day shift and this was mainly because workers on the night shift omitted breakfast and the midday meal from their daily intake of food. Such a finding is not wholly unexpected given that the usual times of breakfast and lunch coincide with the nightworker's rest, and therefore would involve an interruption to sleeping time in order to eat at these specific times. Duchon *et al.* (1990) examined the association between meal frequency, meal regularity, eating satisfaction and self reported health in 101 surface mine workers and found that the type of shift affected the number, timing and consistency of the meals consumed. Only 9% reported that the day shifts interfered with their eating patterns, compared with 52.6% on the afternoon/evening shift and 74.7% on the night shift. In terms of satisfaction with eating habits, those who reported eating at the same time each day tended to give more favourable ratings, whereas those who reported that the number of meals eaten changed from day to day gave less favourable ratings on all three shifts. This latter group also tended to give less favourable ratings of self-reported health. Impaired subjective health was also evidenced for those who reported that soda, alcohol and cigarette intake increased on the night shift. In their conclusion the authors noted that it was interesting that "what is dissatisfying is not necessarily unhealthy" (pp. 119). In support of this, Derby and Bleyer (1972) reported that disturbances of appetite did not lead to a lessening of calorie intake but were instead associated with a dislike of having to eat at unusual times, meaning that family meals that had been prepared at the usual time tended to be cold and eaten alone.

In contrast Lennernäs, Hambræs and Åkerstedt (1990) examined the effect of shiftwork on food pattern, meal distribution, meal frequency and intake of nutrients amongst male shiftworkers in a Swedish engineering plant. After reporting that dayworkers, 2-shift workers and 3-shift workers had the same average food consumption of energy, protein, fat, carbohydrates, saccharose, dietary fibre and ascorbic acid, they concluded that "shiftwork does not seem to have had any great influence on nutrient intake" (pp. 390). In a later study by the same authors (Lennernäs *et al.*, 1993, 1994), using a similar cohort, the same conclusion was reached, with the authors stating that "the types of work hours presented in this study do not affect the total intake of energy, nutrients or the consumption of coffee" (pp. 338) and that "shiftwork does not affect food intake to any great extent" (pp. 251).

However two findings in these later studies were given little attention, yet point to interesting areas for future research. The first appeared in the 1993 study and concerned the finding that the day, 2-shift and 3-shift workers differed significantly in the average amount of alcohol consumed across one work cycle, with 3-shift workers (10g) and dayworkers (9g) consuming higher amounts than those on a 2-shift pattern (3g). Increased alcohol consumption in shiftworkers was also found by Derby and Girault, Lefort and Thiebault (1967, cited in Harrington, 1978). The mechanism for such a finding was not discussed and it is clear that more research into this specific behaviour is needed. It may be, for example, that dayworkers have a greater opportunity to socialise, and drinking alcohol is typically consumed in social situations, thus leading to a higher intake. 3-shift workers, on the other hand, are known to have fewer opportunities for socialising and therefore may use alcohol as a way of winding down from work or relieving the stress caused by work/non-work conflict.

The second interesting point was reported in the 1994 study and concerned the consumption of snacks. Lennernäs *et al.* (1994) reported that the daily intake of energy differed significantly across shifts, reaching their maximum during days with 12h shifts and their minimum during days off. Furthermore, in analysing the overall distribution of meal types they showed that the percentage of complete meals was the same as the consumption of snacks with low nutrient quality (27%). Subjects typically ate 1-2 low quality snacks per day compared with less than 1 per day for snacks categorised as high, or mixed, quality. Moreover, although 44-50% of energy intake came from complete meals, a substantial proportion (13-18%) came from mainly low quality snacks. Whilst complete meals contributed the main part of the intake of fat, low quality snacks played a more important role in contributing to the overall intake of sucrose. Although the authors failed to find any significant variation across shifts for the snack categories, the finer details above nevertheless highlight that in 3-shiftworkers, at least, snacking plays a major role in their nutritional behaviour. This may help to explain the finding by Handijex (1990) that the daily consumption of fat was higher in nightworkers (155.3g) compared to dayworkers (119.1g). Such comments are speculation but point to an interesting and as yet uncharted area of research. However, since the intake of energy can affect the performance and efficiency of workers, the implications of such research in the prevention of accidents or the stability of productivity becomes clear.

As with those areas already discussed, a major weakness in this area is the methodology used often causing difficulties in comparing and generalising from the results. For the most part, studies have failed to use established methods in the collection of qualitative and quantitative data on food consumption, such as the use of food diaries and 24h recall, since they are often very time consuming, requiring detailed data on the type and amount of food eaten in addition to the timing of each meal. Moreover, where analyses of meal patterns have been employed they have rarely been approached from a qualitative, nutritional point of view (using knowledge of the combination of food items that represent different nutritional qualities) but have instead classified meals according to their temporal distribution (breakfast, lunch, dinner, supper), on the temperature of the food (cooked/uncooked, hot/cold), or simply on the number of meals consumed per day, without specifying what these meals consist of. In their 1993 study Lennernäs *et al.* proposed a new measure of meal classification involving the categorisation of food items from the Swedish nutrient database into 10 food groups, 6 of which contained foods with a high content of essential nutrients per energy unit, and 4 of which contained foods with a low content. On this basis meals and snacks were categorised according to the presence and combination of food items from the food groups. Based on this criteria they defined 3 types of meals (complete, incomplete and balanced) and 3 types of snacks (low quality, mixed quality, high quality). One only has to look back at the evidence presented above from the use of such a measure to see its superiority in highlighting the intricacies of shiftworkers' eating behaviour.

There is meagre scientific evidence in the literature on which to base dietary guidelines for shiftworkers, in terms of optimal meal patterns or recommendations for the composition of meals depending on the type of shift worked. What is more, any that does exist is generally pop psychology in that it relies on general knowledge and assumptions rather than on hard scientific fact. Since the impact of shiftwork on the eating behaviour and diet of shiftworkers is still in its infancy there are many and varied angles that can be taken in future research. For example, little or no work has been conducted on the question of the optimal timing and length of breaks within the working day, nor whether the provision of on-site canteen facilities help or hinder the eating habits of shiftworkers (although this was touched upon by Lennernäs *et al.*,1994). Work could also be conducted into whether the need for energy changes during specific shifts, controlling for such confounding variables as age, gender, job type, workload, shiftwork exposure and so on, or the reasons underlying snacking behaviour and whether the double burden attributed to women significantly impairs their diet. On this latter point, for example, it may be that female shiftworkers with children actually eat more regularly since they provide meals for their children and join in with them. Of course the major implication of such work is in the education of workers, in the design of work schedules which limit the amount of dietary disruption, and in the design of diets that tackle the problems faced by those who work shifts.

2.6. Social Problems

Shiftwork not only affects the working life of an individual but can also influence their personal life. It is well established that the unusual scheduling of work interferes with the opportunity for social integration and the quality of social and leisure time (Brown, 1975; Maurice, 1975; Carpentier and Cazamian, 1977; Bunnage, 1984; Folkard *et al.*, 1985; Walker, 1985). Shiftworkers, and in particular those on rotating schedules, are generally out of synch with the rest of society and lack the social integration that results from such interaction. Shiftworkers have been found to have problems visiting friends, family and co-workers (Mott *et al.*, 1965; Walker, 1985; Colligan *et al.*, 1990; Skipper *et al.*, 1990), and have fewer friends as a consequence (Herbert, 1983; Walker 1985). They also miss out on being active members of organisations and participating in institutionalised activities (Mott *et al.*, 1965; Folkard *et al.*, 1985; Schmeider and Smith, 1996), are often obliged to give up some form of hobby or leisure activity (Andersen, 1970) and spend more time in solitary activities (Walker, 1985) often complaining of feelings of social isolation and depersonalisation (Mann and Hoffman, 1960, Gardell *et al.*, 1968; Fischer *et al.*, 1993). Thus, in the words of Walker (1985) "Shiftworkers may not be fully integrated in the communities in which they live and work; they themselves may feel this and other members of their community may not regard them as fully part of it. The shiftworker may be considered in some sense a 'marginal man' " (pp. 214).

Time budget studies, where individuals are asked to keep a diary of their activities over a 24h period (Bullock *et al.*, 1974; Rutenfranz, Knauth, Kupper, Romahn and Ernst, 1981), have shown that patterns of social activity generally follow a circadian rhythm and can vary according to weekly and seasonal variations. However, unlike the problems associated with sleep, diet and health, the social problems which can result from working shifts tend to rely more on situational rather than physiological factors and can be affected by a number of confounding variables. For example, the extent to which abnormal hours affect the social life of the shiftworker can vary according to the type of shift system worked, the location of the work, family circumstances, domestic responsibilities, socio-economic status, local leisure facilities, and gender (Brown, 1975; Nachreiner, Baer, Diekmann and Ernst, 1984; Volger, Ernst, Nachreiner and Hanecke, 1988; Clark, 1990; Colligan and Rosa, 1990; Kirkcaldy and Redgrove, 1991; Fischer, Moreno, Fernandez, Berwerth, Coffani dos Santos and Bruni, 1993; Kirkcaldy and Cooper, 1992). Furthermore, according to Wedderburn (1975) the sheer variety of individuals' preferences and habits in their social lives defies reduction to a few generalisations. Despite these reservations however, at a very general level, certain patterns have been commonly shown throughout the literature.

2.6.1. The Value of Leisure Time Units

An important concept in this respect is the 'value of leisure time units' and the recognition that there is a distinct pattern in the value of time off work depending on its chronological position. This was well emphasised by a shiftworker in a study by Sergeans (1971) who simply pointed out that "Wednesday is not Saturday". Thus the working schedule determines the amount and place of leisure time in addition to determining the opportunities one has to spend the time as desired (Meijer and Tham, 1990). The provision of leisure activities and the amount of free time can greatly affect how the shiftworkers free time is used. For example, to the nightworker, free time in the morning has little social and leisure utility since it is typically used for sleep. However, the early evening before their shift may be seen as highly valued since it is a time at which they are able to integrate with the family and join in with the family meal.

Using matched groups of shiftworkers and dayworkers, Wedderburn (1981) obtained the subjective value of different hours of the week and found weekends to be more highly valued for social activities than weekdays, Saturday night to be the peak value for time off work and evenings to be more highly valued than time off during the day. In combination with this, many activities are restricted to certain hours of the day or night. Leisure centres, pubs and cinemas are generally not open 24 hours a day, for example. If the pattern of a leisure activity overlaps with the person's working hours their opportunity to pursue this activity will be greatly reduced (although this will vary with the flexibility of the time needed to pursue that activity). The more important the activity is for the person, the more negatively he will regard the restricting influence exercised by his work (Blakelock, 1960; Vroom, 1964; Wedderburn, 1981). In support of this, Herbert (1983) examined (i) the type of leisure activities and social habits that either facilitated adaptation to shiftwork or made adaptation more difficult, (ii) whether interference of the work schedule with leisure activities explained the attitude towards shiftwork and willingness to stay in the job, and (iii) whether a person's leisure activities and their appreciation of them changed during a period of shiftwork. He found that shiftwork tended to facilitate so-called 'time flexible activities' and were those that were not necessarily organised and therefore could be easily fitted into the time available. These generally took the form of household chores, shopping, maintenance of the house and errands, such as posting letters and attending dentist or doctors appointments. Inflexible, organised activities, such as seeing others, club, union, local government or sports activities, were hindered the most by shiftwork (Carpentier and Cazamian, 1977). Herbert noted that as shiftwork exposure increased so did the number of flexible activities that were considered to be important, whilst the inflexible activities decreased. This suggests that workers were adapting to shiftwork by arranging their lifestyles to fit around their work schedule. For those who had given up shiftwork, the degree of hindrance to leisure activities was much greater than they had originally expected, whilst for those who had stayed, the hindrance was perceived as being less than they had expected. This last point was supported by both Wedderburn (1978) and Bohle and Tilley (1998) who found the impairment of social life to be the most frequently nominated reason for disliking shiftwork.

2.6.2. Compensation for Inconvenience

The positive value of leisure time is universally acknowledged and the inconveniences of shiftwork on this time are recognised in the form of shiftwork premiums, which can be seen as a form of compensation for having to work at highly valued times of the day and week. Although such bonuses are based on a simple model of exchange, in that the higher the inconvenience the higher the bonus, there are wide variations and weaknesses both in the framework used and within and between industries, occupations, and countries (Jansen, 1987; ILO, 1990). Indeed Van Limborgh (1995) concluded that "there are as many different shift premium systems as there are collective agreements" and that "no consensus exists on the assessed inconvenience of shift schedules in different countries or organisations" (pp. 342). An additional problem was pointed out by Baer *et al.* (1981) who posited that the subjective utility and utilisation potential of an hour off work can differ for each person depending on the value systems of the person involved.

Despite such variation, Wedderburn (1981) attempted to generalise the state of the compensation system and tabulated the commonest patterns of extra payments related to the time of the day and week. He estimated that the highest 'compensation' was given for the weekends, with Sunday night (20:00-06:00 Monday) being 240%, Sunday daytime (06:00-20:00) at 200%, followed by Saturday night (20:00-06:00 Monday) at 180% and Saturday daytime (06:00 to 20:00) at 150%. Weekday nights (Monday-Friday, 20:00-06:00) were estimated at 120%, and weekday daytimes (Monday to Friday 06:00-20:00) 100%. Recent work has attempted to develop a system for computing and predicting the inconvenience of shift schedules from the schedule characteristics themselves (Grzech-Sukalo, Hedden and Nachreiner, 1990; Van Limborgh, 1995) whilst others have concentrated on establishing a relationship between the experienced severity of the inconveniences and shift bonuses (Tham and Meijer, 1990). However, some have questioned the actual value of such counter-weight compensation methods (Thierry, 1980) since they do not actually address the problems of shiftworkers. In other words, if a shiftworker is unable to attend an evening class due to their work schedule, the shift premium will not help them in their wish to study. A possible alternative to shift bonuses was suggested by Van Limborgh (1995) who argued that a counter-value model of compensation, whereby the actual inconveniences are addressed and reduced by altering the appropriate design characteristics of the shift schedule, may be more advantageous.

Many countries are now seeking new ways of allocating more time for rest and leisure whilst still maintaining the use of shifts. Flexible Work Options (FWO), whereby the individual is able to schedule their shift pattern around their own personal preferences, and the compressed work week, with the advantage of working fewer shifts but longer hours, are now being introduced more regularly. Little work has been conducted into the possible advantages of FWO but a recent study by Tucker, Barton and Folkard (1996) found that longer periods of time spent away from work as a result of working 12h shifts proved to be an advantage for social and leisure activities, with 12h shiftworkers reporting significantly less disruption to their social life than 8h shiftworkers.

2.6.3. Gender Differences in Social Problems

It is generally acknowledged that women have a greater family responsibility imposed upon them than men, and get less discretionary time than their male counterparts. Oginska, Pokorski and Oginski (1993) found that 48% of female shiftworkers spent the majority of their time away from work doing housework, while men reported spending no time in this way. Sekaran (1985) reported that women have less discretionary time than their partners due to the greater responsibilities imposed upon them by marriage and family, and generally reported one hour less leisure time each day than their partners. Loudon and Bohle (1997) found that work/non-work conflict was particularly salient for female shiftworkers living with a partner and dependent children, and that women in this group spent more time on domestic work than either married women without children or single women, and less on leisure time than single women. Robson and Wedderburn (1990) reported that married women (15%) attended sports and social clubs less often than single men (47%), married men (49%) and single women (60%).

2.6.4. Social Life and Health

The importance of a rewarding social life has been highlighted by research showing a possible link between an impaired social life and health. According to Knutsson and Åkerstedt (1990) "there are indications that the social environment may act as an independent pathway from shiftwork to disease" (pp. 381). Indeed, Bohle (1990) found a relationship between work/non-work conflict and psychological symptoms when subjects were working very frequent evening shifts, challenging the assertion of Rutenfranz *et al.* (1985) that social and organisational factors should only have a marked effect on well being when they occur in conjunction with night shifts.

Cohen (1988) suggested that shiftworkers may be at an increased risk of stress related illness since social networks are known to buffer individuals from stressors in the environment. This is particularly important in the light of results showing shiftworkers to have higher levels of stress related outcomes (Koller, 1983; Moore-Ede and Richardson, 1985), that social support diminishes work related stress, and that work related social support modifies the impact of occupational stress on psychological and physical health (Dunkel-Schetter, Folkman and Lazarus, 1987; Brand and Hirsch, 1990). Social support from friends, family, supervisors and co-workers have been linked to indices of adaptation to shiftwork, including mood, psychological well-being, and physical symptoms (Thierry and Jansen, 1982; Revicki and May, 1985; Ganster, Fusilier and Mayes, 1986; Thoits, 1986; Bohle *et al.*, 1989, 1993; Buunk and Peters 1994; Pisarski, Bohle and Callan, 1998). For example, Bohle (1990) found work/non-work conflict and social support from supervisors to be predictors of psychological symptoms. After 15 months of shiftwork, subjects reported low social support from supervisors along with high symptom levels, suggesting that attitudes and behaviours of supervisory staff can have moderating effects on symptoms. In attempting to generalise from these findings, Bohle *et al.* (1998) have suggested that work/non-work conflict is likely to be mediated by social support from various sources. Supportive families may decrease conflict between work and non-work activities by altering meal times or other social activities. Supportive co-workers may mitigate negative effects by providing a more friendly atmosphere on socially isolating shifts or by swapping shifts with colleagues to allow them to attend important events. Supportive supervisors may assist adjustment to difficult shifts by promoting flexibility in the arrangement of shift schedules.

2.6.5. Is Society Beginning to Adapt?

In response to the recognition that shiftworkers are at a disadvantage in terms of the quality of their social and leisure time and the effect it can have on their health and well-being, modern society is perhaps at last beginning to adapt. A recent news brief from a shiftwork consultancy company, reported that the Heartland Golf Park in Deer Park, Long Island, New York operates nearly 24h a day, with the last tee being at 01.30am. Although these night golf sessions cost double that charged during the daytime, to cover the electricity bill for the powerful floodlights that keep the course illuminated, the manager is reported as saying that "we get restaurant workers, police officers, factory workers, you name it. When the weather's good, it's crowded all night, especially on weekends". Perhaps then we are beginning to see the first steps towards the so-called 'nocturnal subculture' suggested by Folkard (1990) as a way of limiting the disruption felt by nightworkers. He proposed that, in addition to working permanently at night, such individuals would continue to be active at night and sleep during the day, even when not at work. Whilst there are clearly problems associated with this approach, in that such 'nocturnal individuals' may miss out further on integration with their family and friends, if nightwork is here to stay, it may well be a scenario soon to be adopted by many shiftworkers involved in permanent nightwork as a viable alternative to missing out altogether.

2.7. Family Problems

In an extensive study involving 1045 shiftworkers and their wives, Mott *et al.* (1965) examined the social, behavioural, and physical consequences of shiftwork. From their analysis they argued that shiftwork has a two-step effect upon family life, with interference to familial roles being a major contributing factor to the problems experienced. During the first stage, conflict between the hours of work and the times usually devoted to a certain role results in interference of valued family activities. So for example, the shiftworker typically spends the weekend period recovering from the sleep deficit they have incurred throughout the week, therefore reducing the amount of contact time with the family, in turn lowering the quality of that time. They also noted that family interaction may be reduced as a result of the shiftworker being fatigued and irritable. During the second stage these conflicts have a cumulative effect upon marital happiness and a reduction in the ability to co-ordinate family activities. It also appears that shiftworkers are aware that their work schedules cause problems. For example, Åkerstedt and Torsvall (1977) found that three-quarters of a group of shiftworkers thought that shiftwork was a major cause of inconvenience in their family life, whilst Knight (1995) found 47% of a sample of employees from over 22 large UK organisations, representing over 1 million white collar workers, admitted that their families suffered from their absence due to their hours of work.

The concept of role disruption has been frequently mentioned throughout the literature as contributing to the family difficulties experienced by shiftworkers (Herbert, 1983; Shamir, 1983; Staines and Pleck, 1984; Jackson, Zedeck and Summers, 1985). Every person has a variety of roles, whether parental, spouse, lover, caregiver or homeowner, to mention only a few. Many have argued that the main adverse effects of shiftwork are not in the amount of time spent in familial roles but in the quality of that time (Tasto *et al.*, 1978; Herbert, 1983; Staines *et al.*, 1984; Voydanoff, 1988).

The fact that familial roles can have an adverse effect on the shiftworker is further illustrated by findings suggesting that women shiftworkers may suffer more than their male counterparts as a consequence (Beerman, Schmidt, Rutenfranz and Saito, 1981; Gadbois, 1981; Brown and Charles, 1982; Oginska *et al.*, 1993; Spelten, Totterdell, Barton and Folkard, 1995). Robson and Wedderburn (1990) found that 79% of married shiftworking mothers worked shifts because it fitted in with their childcare arrangements. Scott *et al.* (1997) found that almost 60% of female shiftworkers reported that shiftwork had 'somewhat' or 'always' interfered with their domestic life, whilst in contrast 54% of male shiftworkers reported that their working schedule had never caused problems in this area. Olsson, Kandolin, and Kauppinen-Toropainen (1990) found that 80% of women compared with only 50% of men thought shiftwork suited their lifestyles, whilst 70% of female industrial workers, compared to only 20% of male workers, reported shiftwork to be advantageous to their family life.

2.7.1. Family Life and Health

An additional adverse effect in relation to family dysfunction is that of health. According to Taylor, Folkard and Shapiro (1997) "removing shift features that interfere with family life may enhance workers' subjective health" (pp.29), and that organisations should support the domestic lives of shiftworkers by maximising the advantages that shiftwork can offer to families. Taylor *et al.* found that although family advantages, such as being able to support their children's activities and allowing the shiftworker and their partner to see each other, predicted less than 5% of the variance in self reported subjective health, family advantages were consistently positively correlated with psychological stress, cognitive and somatic anxiety, chronic fatigue, and digestive and cardiovascular symptoms. Family advantages also independently predicted cognitive anxiety and chronic fatigue when the effects of established predictors of health, shift characteristics and personality had been controlled for. In support of this O'Driscoll (1996) suggested that psychological health effects caused by conflict between home and work roles can range from psychological strain, depression, anxiety, burnout and even substance abuse, whilst Bohle *et al.*(1989, 1993) found a link between self reports of structural work/non-work conflict, and shiftworkers fatigue and general psychological well-being.

Some shiftworkers exploit the opportunities offered by certain shift schedules to fulfil their domestic and family responsibilities, but do so to the detriment of their health (Colligan *et al.*, 1990; Kurumatani, Koda, Nakariri *et al.*, 1994), as was evident in the case of women giving up their sleep in order to satisfy their domestic commitments (Gadbois, 1981). In attempting to interpret the relationship between family life and health, Taylor *et al.* suggest that a shift system conducive to family life may offer the opportunity for regular social support which in turn may moderate occupational stress on health. This may certainly be the case in the light of evidence on the positive effect of social support discussed above.

Other research has pointed to the importance of the characteristics of the shift schedules themselves in determining the amount of family disruption caused (Ernst, Nachreiner and Volger, 1986; Bonitz, Grzech-Sukalo and Nachreiner, 1988; Grzech-Sukalo, Hedden and Nachreiner, 1990; Hedden, Grzech-Sukalo and Nachreiner, 1990). Nilsson (1981) showed that those who worked a 2-shift schedule of mornings and afternoons experienced more interference with their family life than those who worked a 3-shift pattern. Jamal and Jamal (1982) found that fixed shift schedules allowed more family time than rotating schedules, whilst Colligan *et al.* (1990) reported that shiftworkers who worked permanent nights reported having more time with their families than those on both permanent afternoon shifts or rotating schedules. Grzech-Sukalo and Nachreiner (1997) found that characteristics of the shift schedule interact with additional restrictions imposed by the time schedules of the shiftworker's partner and children to determine the amount of psychological impairment they suffered. Rigid schedules increased the difficulties of synchronisation and resulted in a higher level of impairment, whilst for more flexible schedules less impairment was observed.

2.7.2. The Quality of Relationships

The situation may also be worse when both partners are shiftworkers, a practise often undertaken to ensure effective childcare arrangements. However, whilst such working patterns can lead to a reduction of childcare fees, they inevitably reduce the amount of time spent together and can prove to be very expensive in terms of the quality of the relationship. Although the effects of shiftwork on such relationships will depend on a number of factors, such as whether the joint shiftworking schedule was forced upon individuals or chosen, the type of shift systems worked, or the state of the relationship, one must only assume that the quality of a relationship will be hampered under such circumstances.

However, the question of divorce rates in shiftworkers is a contentious one, for whilst Carpentier *et al.* (1977) reported a tendency for higher divorce rates amongst shiftworkers, Andersen (1957) did not find any differences between dayworkers and shiftworkers. The 20 year difference between the two studies may help to explain the findings, since it is known that divorce rates have steadily increased throughout this time. However, in the most recent study, Koller *et al.* (1978) reported the lowest divorce rate in the shiftworking group and the highest in the dropout group, suggesting that relationship problems may be one reason why individuals give up working shifts in favour of daywork.

2.7.3. The Forgotten Victims of Shiftwork

Up until this point we have been dealing with direct effects of shiftwork on the shiftworker himself. However, there is evidence to suggest that the partners and children of shiftworkers may be susceptible to the same adverse effects as those actually involved in shiftwork, since they often have to rearrange their time and routines around the shift schedule in order to maximise both the quality and quantity of family time. Whilst this is a somewhat obvious assumption to draw it is surprising that partners and children are often the forgotten parties, given little support or recognition in their plight. This is evidenced by the paucity of research in this area to date. Indeed, Clarke (1984) argues that the impact of shiftwork cannot be adequately studied by simply focusing on the shiftworkers alone but must take account of the entire household.

2.7.3.1. Partners

In a study of the attitudes of the wives of continuous shiftworkers, Banks (1956) reported partners as citing their husbands' work schedule to be the most significant cause of disruption to their social lives, especially during the more highly valued weekend periods. De la Mare and Walker (1968) found that the primary reason for a group of males working the dayshift was the fact that their wives felt nervous and lonely during the night and evening. Classifying the major disadvantages to the wives of husbands working night shifts, Brown (1959) listed interference with daily household chores, the strain of keeping children quiet in order to protect the shiftworkers day sleep, nervousness and loneliness at night, poor social life and problems in preparing meals.

In a more recent study, Smith and Folkard (1993) examined the indirect impact of shiftwork on the partners of shiftworkers in order to examine whether their problems were related to those of the worker. Using the perspective of partners themselves Smith *et al.* found that 53.3% of partners rated themselves to be 'fairly' or 'very' unhappy about their husbands' shiftwork, with approximately one-third having tried to persuade their husband's to give up. When asked the extent to which their lives had been disrupted, 67.6% reported moderate to high levels and included areas such as having to adapt to their husbands rota, impaired joint and personal social life, impaired contact with the children, high conflict and poor intimate relations. When partners were asked to rate the degree to which they had had to alter aspects of their lives, attempting to keep noise down during the day, being alone during the night and evenings, and having to prepare and eat meals at odd times were reported. Overall the most significant disruption to partners' lives occurred during the night shift which was also associated with greater sleep, health, social and family problems as well as higher levels of fatigue in the shiftworkers themselves. To conclude Smith *et al.* stated that "This rarely studied group is a potential source of important information regarding the extent to which shiftwork influences the lives of shiftworkers and their families and as such merits further research" (pp. 304). In support Wedderburn and Robson (1990) stated that "Partners are not often included in surveys of shiftworkers, but they are certainly affected by their partner's odd hours" (pp. 7).

2.7.3.2. Children

Research conducted on the effect of shiftwork on children has centred around two main areas. First is the effect on the child's scholastic career, whilst the second covers the emotional and affective state of the child, and in particular the prevalence of depression.

Jugel, Spangenberg and Stollberg (1978, cited in Volger *et al.*, 1988) found that end of year grades in a German school, taken as an indication of school performance, were lower in children with shiftworking parents compared to those with dayworking parents. Whilst this was only significantly lower in children where both parents were shiftworkers, the same tendency was also observed with only one. They also noted that shiftworking parents attended less 'consultation days' and were less likely to belong to school councils than dayworking parents, although this was much more likely when both parents worked shifts. The suggestion that this can translate into achievement at school is supported in a number of studies. Barton, Aldridge and Smith (1998) found that daughters of shiftworking fathers reported significantly poorer perceptions of their academic ability in school related activities and significantly greater discrepancies between their perceived overall level, and their ideal level, of competence. Using a Belgian cohort, Maasen (1980) found that the proportion of children leaving school at the first opportunity when school attendance was no longer obligatory was higher in children of shiftworkers than those of dayworkers. This translated into the fact that the children of shiftworkers not only entered into working life earlier but also had fewer qualifications than those of dayworkers. In support the relative proportion of children in more theoretical branches of education was comparatively higher amongst children of dayworkers, whereas children of shiftworkers tended to pass a more practical education. Furthermore, after controlling for the confounding variables of the father's qualification levels and the mother's employment, Diekmann *et al.* (1981, cited in Volger *et al.*, 1988) found a negative relationship between the school career of the children of shiftworking fathers. Furthermore, a common finding from such studies is that school performance depends not only on whether one or both parents are shiftworkers but also on the type of shift schedule worked. According to the results of Jugel *et al.*(1978) and Maasen (1980) school achievement is best in children of dayworkers, and worst in those whose fathers work continuous shifts, whilst the children of 2-shiftworkers performed better than those of 3-shiftworkers.

In attempting to interpret these findings research has focussed on the lack of time shiftworkers spend with their children both in school and non-school activities. Because the time schedules of shiftworkers are severely desynchronised from the time schedules of the rest of the family, they have less contact with their children, compared to dayworkers, and this might be responsible for the impaired school achievement of their children. In an examination of father-child interactions in children between the ages of 4 and 10, Repetti (1989) found that the father's difficult work conditions were associated with lower levels of both positive and negative emotional involvement with their children. Volger *et al.* (1988) examined the chronological position of common free time of fathers under different shift systems according to age of the children. They found that the amount of common time that the parent and pre-school child had to spend together was greater in shiftworkers than dayworkers, mainly because young children are awake during the day when their fathers are at work and in bed by the time they arrive home. Shiftworking fathers, on the other hand, have free time following morning shifts and before afternoon shifts, maximising common time together and therefore the opportunity for interaction. For fathers with school age children however, the findings were reversed with dayworkers showing superiority over shiftworkers. This was mainly attributable to the fact that with increasing age of the child, bedtimes become later, allowing better synchronisation of the fathers and child's time schedules. However, not all shiftworking systems had the same effect. Those on 12h systems had no common free time throughout a week of day shifts since the beginning and the end of the shift coincided with the child's rise and bedtime respectively. Slowly rotating systems gave more common free time than rapidly rotating systems. Similar findings have been reported by both Rutenfranz *et al.* (1980) and Wedderburn (1975).

However, Volger *et al.* (1988) go on to discuss the possibility that it might not be the amount of time that the father and child spend together that matters most, but the quality of this time. This is particularly pertinent when comparing the father-child interaction in cases where fathers have finished either a run of night shifts, often resulting in a high level of fatigue and possibly irritability, or a run of afternoon shifts, where sleep deficits are known to be much lower. Whilst the same amount of time may be spent with the child, the latter scenario, in which the father would be expected to be more refreshed and need little adjustment to a daytime routine, will be much more rewarding for both the parent and the child.

The emotional impact of shiftwork on primary school age children of shiftworkers was studied by Barton *et al.* (1998). Daughters of shiftworking fathers were found to have a higher level of depressive symptomatology, a lower level of self esteem and held more negative views about themselves, compared with the daughters of dayworking fathers (although the two were not significantly different). However, the mediating effects of paternal shiftwork on the affective state of children remains unclear. Shiftworking families are known to experience a greater number of problems and life stresses than dayworking families (Walker, 1985; Monk and Folkard, 1992), and stressful life events have been associated with the development of child behavioural and psychological disorders (Rutter, 1990; Harrington, 1994). Interestingly those factors that have been mentioned as being specific risk factors in this respect are those that are known to occur in shiftworking families. These include lack of parental social support (Wettleib, Weigel and Feldstein, 1989) and conflict and tensions within the family (Mott *et al.*, 1965; Downey and Coyne, 1990), both of which have been supported within the shiftwork literature. Indeed, Barton *et al.* (1998) concluded that "parental shiftwork may be experienced as stressful within the family, and this stress may affect the emotional state of the child" (pp.146).

An additional risk factor of specific interest is the emotional state of the parent (Dix, 1991; Cummings *et al.*, 1994). Research into this area has suggested that parental depression can place the child at risk of developing anxiety, anger, dysphoria, depression, social withdrawal and problems with self-efficacy (White, 1959; Hammen, 1988; Cohn and Campbell, 1992). Shiftworkers are known to be adversely affected in terms of both their physical and psychological health as a result of working shifts and it is possible that the findings of Barton *et al.* (1998) were due to the behavioural and emotional problems of their shiftworking parents. Affirmation of this hypothesis however, is impossible since the affective state of the shiftworking fathers was not assessed. Cummings and Davies (1994) postulate that parental depression may affect the child directly through the emotional unavailability and thinking processes typical of depression, and indirectly by altering the patterns of the parent-child interaction, since depressed individuals cease to be active members of the family and are typically withdrawn. More extensive research addressing such hypothetical pathological pathways is needed before we are able to fully understand the ways in which shiftwork affects the psychological health of the children of shiftworking parents. Studies assessing the psychological health of both the parent and child are needed. Additionally, to the author's knowledge, no research has been conducted into whether the affective state of children is worse if both parents are engaged in shiftwork, or the specific features of shift schedules associated with the highest risk.

2.8. Attitudes toward Shiftwork

Unlike many of the areas mentioned in the review, relatively little work has been conducted on individuals' attitudes and how these may affect, or be affected by, adaptation to abnormal hours of work. Where there have been studies, attitudes have generally been treated as subsidiary to other, more measurable, problems, such as illness and absenteeism. Attempts to examine the dimension have also come under fire for the types of global single-item measures, or short composite scales used, or the tendency to use open questioning, each lacking in sound psychometric principles, which some authors argue may account for the limited and often inconsistent findings (Iskra-Golec, 1993). Bohle *et al.* (1998) argue that using such measures effectively conceal the decision making process upon which satisfaction is based. Indeed, Bunnage (1984) argues that the advantages and disadvantages expressed towards shiftwork are likely to be influenced by a number of factors, from the type of shift worked, to personal circumstances (such as occupation, age, gender, marital status, health and so on), family situation (including attitudes of other family members), and situational circumstances in both the workplace and the environment, and that those given more choice in their working life will have more favourable attitudes. Some workers, perhaps the vast majority, choose to work shifts because of the lack of alternative employment opportunities. Others, such as emergency services, healthcare workers and airline crews, to name but a few, must be prepared to work shifts due to the demands of their profession. Research has linked many situational and individual difference variables to satisfaction with shiftwork, with demographic, personality, behavioural, health status, work/non-work conflict, characteristics of the shift pattern and perceptions of the work environment, being prominent amongst them (Nachreiner, 1975; Patkai and Dahlgren, 1981; Zedeck *et al.*, 1983; Bohle *et al.*, 1998).

Whilst many workers are aware of the negative affects associated with shiftwork, dissatisfaction with work patterns is not necessarily accompanied by a desire for change. Indeed, Nachreiner (1975) suggests that an individual's evaluation of shiftwork may be based on their experiences and impressions of it, whereas the desire to change involves other situational variables (e.g., the possibility of alterative employment, the likelihood of maintaining similar wages, the ability to have a second-job, and family arrangements such as childcare and free time at different points throughout the cycle). In some cases these are important advantages that can outweigh the disadvantages involved.

Studies also show that shiftworkers themselves have an important role in improving or impairing the problems they face as a result of working abnormal hours. According to Härmä (1993), the concept of 'commitment to shiftwork' may be the most important individual factor in this respect. Defined as the willingness of shiftworkers to schedule their lives, and especially their sleeping habits, to working at unusual hours (Folkard *et al.*, 1978; Minors and Waterhouse, 1983, Monk and Folkard, 1985), the level of commitment can determine how well an individual copes with the strains of shiftwork.

2.9. Summary and Discussion

Shiftwork is essentially an unnatural way of life for the diurnal man, and one that disrupts the temporal organisation of work and leisure time, forcing the shiftworker to act against both biological and societal rhythms. The type of shift worked determines the amount and distribution of time spent outside of work, with the placement of this time in both the day and week ultimately affecting the quality of sleep, diet, leisure, social and domestic interactions, and so on. Furthermore, even where workers take steps to improve their situation they may be hindered by the rigid circadian rhythms of many biological functions. Thus for example, the nightworker who attempts to sleep during the day is doing so at a time that is both biologically and situationally inappropriate. Likewise, the worker who goes to bed early in preparation for an early start may be hampered from doing so by the forbidden zone for sleep onset. Adaptation calls for a commitment to shiftwork which involves the worker adopting a lifestyle and not just a pattern of work. It is hardly surprising that this is a commitment which some are reticent to give.

Despite the fact that much of the literature in this area concentrates on the negative effects of shiftwork, it is important to remember that some people positively enjoy working shifts, allowing them to take advantage of shift premiums and the ability to organise home and work responsibilities, especially childcare arrangements. Yet if we bear in mind the practical implications of shiftwork research, that is to achieve the best compromise between the business and the worker, it is paramount that all variables be considered. In compensating for the negative effects of shiftwork we must not lose sight of the advantages.

Although the study of shiftwork, both in the design of work schedules and the investigation of outcome variables is gaining in strength, a major problem facing those who attempt to explain the underlying mechanisms is that the results of each study tend to introduce either additional variables not before linked to shiftwork, or original ways in which variables are combined to produce their effects. Thus researchers are faced with, what seems to be, an ever-increasing number of variables being added to the list of those connected with shiftwork in one way or another. One such reason for this is the myriad methodologies employed in research making comparisons between studies extremely difficult, and conclusions acutely hazardous. Research in this area has become so exhaustive that most reviews are forced to be selective (focusing on the field study of sleep in nurses on specific shift schedules, for example) when discussing previous work. More rigorous and standardised methodologies are now needed in a quest to take account of where the advances are in this area and how the body of knowledge can be utilised to the benefit of those affected by shiftwork.

A number of authors have proposed, at least theoretically, that the depth of knowledge can be used as selection criteria in order to evaluate those individuals who are most at risk from, or not suitable for, shiftwork. Indeed, as noted earlier, as a result of Thiis-Evensen's work in the 1950's, pre-employment screening of individuals took place in the Norwegian industrial plant used as a basis for the study. Most of these criteria were concerned with the exacerbation of various types of morbidity, especially those individuals with various disorders or susceptibilities to disease, which could be worsened by shiftwork. Although each individual's problems will need to be assessed in the light of their personal and situational backgrounds (since certain disorders may be more easily managed by a change in habits, for example) it has been proposed that, on the grounds of present knowledge, the following groups should be counselled against shiftwork, especially where nightwork is involved (Harrington, 1978; Monk *et al.*, 1996; Costa *et al.*, 2000). This includes those with:

- chronic sleep disturbances;
- malignant tumours;
- chronic heart disease, such as severe hypertension, angina pectoris, myocardial infarction within the last 12 months, or impaired heart function;
- gastrointestinal disorders, such as peptic or duodenal ulcers;
- recurrent problems of indigestion or related disorders;
- affective disorders, such depression and anxiety;
- drug or alcohol addictions;
- disorders encouraged by disruption of the sleep/wake cycle, such as epilepsy requiring medication, and asthma;

or those:

- on chronic medication in which the timing of administration is important, such as insulin-dependant diabetes, thyrotoxicosis, hyperthyroidism and adrenal pathologies;
- who are pregnant or have menstrual or reproductive problems.

Additional criteria for nightwork employment specifically have also been proposed on the grounds of non-medical reasons. These include:

- women with small children (under the age of 6 years);
- long distance commuters;
- those with vision impairment.

Whether such a list may be used as a tool in the selection process is a matter of debate. However the points above, although not extensive, illustrate the importance and the potential utility of research efforts in showing the health risks of shiftwork. It is undeniable that as our knowledge grows, so too will the criteria.

The moral of this review is that shiftwork, by its very nature, can involve a number of different shift schedule designs, each of which has its own set of advantages and disadvantages. Shiftwork is not a simple problem and so does not have a simple solution. Although we can counsel certain individuals against working shifts, our knowledge to date does not allow us to rule people out or deny them the opportunity to work shifts, since doing so, in most cases, would be to deny them of their right to shift premiums or the opportunity of time arrangements which allow them to more easily deal with their work and non-work commitments. Research has come a long way towards gaining a better understanding of the outcomes of shiftwork. However many research questions remain unanswered and still more needs to be done before we may be able to even begin to understand the complex interaction of the shiftworkers problems. Future research needs to build on our knowledge to date, taking a more in-depth and multi-directional approach studying the individual as a whole and not just as a 'shiftworker'.

The next chapter attempts to do this by reviewing the large body of literature linking the characteristics of an individual to their ability to cope, or adapt, to shiftwork.

3

MODIFIERS OF SHIFTWORK TOLERANCE

3.1. Introduction

In the previous chapter the large body of literature on the major problem domains associated with shiftwork was reviewed, and discussed how these domains can form multi-dimensional relationships that influence the extent to which certain outcomes are experienced. In this chapter a second set of variables with the potential to modify an individual's tolerance to shiftwork are introduced. In the first instance a short review of shift system features is discussed, highlighting the importance of shift type in the development of problems. Following this variables traditionally covered under the heading of individual differences are discussed, and introduce chronobiological, personality, demographic and work related variables, all of which have been linked to the ability to tolerate shifts. As with the previous chapter, interactions between modifier variables are also explored. In the final discussion the methodological weaknesses affecting the interpretability and generalisability of the evidence is highlighted, paying particular attention to the scepticism surrounding attempts to establish cause and effect, especially in the light of the 'healthy shiftworker effect'. Implications of using such knowledge in predicting future 'good' and 'bad' shiftworkers are also examined.

3.1.1. The Nature of Shiftwork

Underlying the shiftwork literature is the belief that, central to the shiftworker's problems are disturbed circadian rhythms and, according to certain characteristics of the shift schedules employed (e.g., the type of schedule: continuous, semi-continuous, rotating, permanent; direction of the rotation: advance vs. delay; length of the shift cycle, number of consecutive shifts worked, start and end times of the shifts, and so on), the circadian rhythms of the body can become more or less dissociated in their normal patterns and relationships. For example, when working nights, shiftworkers are forced to invert their normal pattern of night sleep and day activity, whilst the zeitgebers impinging upon them, such as the light-dark cycle, timing of meals and social cues, remain stable. This inversion results in a progressive shift in circadian phase that can become more or less pronounced as the number of successive shifts increases.

The direction of rotation can affect whether this shift of phase will be advanced or delayed, according to the forward (morning-afternoon-night) or backward (afternoon-morning-night) rotation of the schedule. The circadian system appears to adjust better to a delay in phase. Studies of transmeridian flights and subjects that have been isolated from all time cues have illustrated that the body clock tends to naturally free-run to around 25h as opposed to the 24h that our environment and society entrain it to. Although a delay in circadian phase is preferable, it is by no means optimal. Adjustment appears to be more rapid for variables known to have a strong exogenous component (such as heart rate, blood pressure and catecholamines) and slower for those with a strong endogenous component (such as core body temperature, cortisol secretion and urinary K^+), and thus a delay in circadian phase can result in desynchronisation of the exogenous and endogenous components of the body clock.

Despite this difference in rates of adjustment, the circadian system never or rarely adjusts completely to such change, even in situations where shiftworkers are placed on permanent night shifts. Indeed, the major finding of both laboratory and applied research is that the circadian reaction to shiftwork is a flattening of circadian amplitude and a partial shift in circadian phase. Unlike in the case of transmeridian flights where the light-dark cycle concomitantly alters in line with the transition in time zone, for the shiftworker, the time cues that help to keep the rhythm on track, continue to be in the opposite direction to the altered sleep-wake cycle. Thus the shiftworker is forced to sleep in the daytime when light, heat and noise are at their height, to modify the regular timing of meals, and to miss out on family occasions and social events. This is further frustrated by the fact that nightworkers typically return to their more natural daytime tendencies during rest days.

The speed of rotation is an additional key feature in how a worker adjusts to their shift schedule. In the case of more slowly rotating systems, such as those changing on a weekly basis, circadian adjustment is compounded by the continuous changeover. In contrast, a schedule based around a fast rotation, although thought to be preferable, has its own problems, since the phase shift of the endogenous components of the body clock is usually due only to the masking influence of the stronger endogenous components, and not to the adjustment of the body clock as a whole. Despite this, general agreement in the field argues that a rapid rotation of shifts, so that adaptation is by no means complete, is far better than a slower rotation, during which adaptation is at least partial (Reinberg, Vieux, Andlauer, Guillet and Nicolai, 1980; Minors and Waterhouse, 1983).

3.2. Individual Differences in Shiftwork Tolerance

According to Härmä (1993) the existence of complaints amongst shiftworkers is highly individual. Indeed, in the quest to identify the 'ideal' shiftworker, clinical evidence has argued that in a population of healthy adults, only a limited number of people will be able to sustain shiftwork. In his now classic, and often quoted, review of the literature on shiftwork and health, Harrington (1978) concluded that "...it appears that for one reason or another 20-30% of shiftworkers do not like it, perhaps the majority tolerate it, and a few, around 10%, actually like it" (pp. 15). Such estimates have been more or less supported with the likes of Costa (1986) estimating that approximately 20% of all shiftworkers have to leave shiftwork after a short time due to 'serious troubles'; only 10% do not complain about shiftwork at all during their working life; while the overwhelming majority simply endure it. Likewise, Harrington (1978) argues that 20-30% of workers leave shiftwork within 2-3 years due to health problems, and according to Folkard *et al.* (1985) 60% tolerate shiftwork reasonably well. Olsson *et al.* (1990) found that 80% of women and 50% of men thought that shiftwork suited their lifestyles, whereas 77% of women and 57% of men thought that it suited their characters. In addition to characteristics of the shift systems themselves, certain individual differences have been shown to influence the circadian adjustment to shiftwork, from chronobiological factors and dimensions of personality to demographical factors and job satisfaction. The following sections aim to review the major findings in this area, highlighting the problems surrounding such research and, consequently, the caution with which conclusions should be made.

3.2.1. ***Chronobiological***

The study of circadian rhythms has yielded many insights into the aetiology of shiftwork tolerance, providing evidence that individual differences in circadian characteristics may underlie differences in adaptation to shiftwork. Indeed, as strongly purported throughout the shiftwork literature, disturbance of the normal circadian synchronisation of a myriad psychophysiological functions is one of the main detrimental effects of shiftwork, and nightwork in particular. According to Reinberg *et al.* (1989) the extent to which an individual is able to adapt to working shifts may be moderated by their sensitivity to internal desynchronisation. This was based on a series of studies showing the temperature rhythm of shiftwork intolerant people to free-run at periods different than 24h and become desynchronised from their rest-activity rhythms, while those of shiftwork tolerant people did not (Reinberg *et al.*, 1984, 1989). The recognition that individual differences in circadian rhythms may play a role in adjustment to shiftwork has led to the construction of a number of predictive self-report measures in an attempt to tap into them (Horne and Östberg, 1976; Folkard, Monk and Lobban, 1979, Torsvall and Åkerstedt, 1980; Moog, 1981; Folkard, 1987; Smith, Reilly and Midkiff, 1989). These have been used with varying degrees of success in a large number of studies, and their use has enabled 3 main areas of the circadian rhythm to be recognised as possible predictors of shiftwork tolerance.

3.2.1.1. Circadian Phase

The first and certainly the most widely researched in this respect are phase differences, with the likes of Freeman and Hovland (1934) and Kleitman (1939) making the first attempts to reduce reported phase differences into distinct types according to the time of day that individuals reach their peak body temperature and performance functions. Labelled as the morningness-eveningness dimension, interest soon became widespread with versions of inventories designed for its measurement being developed, and standardised for use, in many countries, including UK (Horne *et al.*, 1976; Torsvall and Åkerstedt, 1980; Smith *et al.* 1989), USA (Posey and Ford, 1981), Italy (Meccaci and Zani, 1983), Netherlands (Kerkhof, 1984), Japan (Ishihara *et al.*, 1986), Portugal (Benedito-Silva, Menna-Barreto, Cipolla-Neto, Marques and Tenreiro, 1989) and Spain (Adan and Almirall, 1990).

The morningness-eveningness dimension that has resulted categorises individuals along a continuum with 'larks', or 'Morning types' (M-types), and 'owls', or 'Evening types' (E-types) at the extremes. Although the classification is commonly used outside the discipline of psychology, its use in studies of shiftwork has been the subject of much debate. For example, Waterhouse *et al.* (1992) point out that extreme larks and owls make up only 5% of the population, with most of the workforce varying from each other by only a small amount, whereas Kerkhof (1985a) argues that the dichotomy is the most powerful inter-individual difference in circadian rhythmicity and one related to biological, attitudinal and behavioural differences among people. The wealth of research in both shiftwork and non-shiftwork related settings has been in accordance with the latter statement. M-types reach the peak of certain physiological parameters at different times than E-types, reaching their maximum body temperature over the day approximately 1.5-3h earlier (Blake, 1967; Blake and Corcoran, 1972, Eysenck and Folkard, 1980). They also have higher efficiency in the morning (Colquhoun, 1960; Revelle, Humphreys, Simon, and Gilliland, 1980) and prefer to concentrate their daily activity in the early part of the day, rising early in the morning and retiring to bed early in the evening. In contrast, E-types prefer to get up and stay up later but have pronounced problems when forced into an early routine (Kerkhof, 1985; Tankova, Adan and Buela-Casal, 1994; Natale and Cicogna, 1996). Whether the sleep-wake behaviour of the two types results in different actual sleep lengths is a matter of some controversy with the likes of Horne *et al.* (1976, 1977), Webb and Bonnet (1978), and Royant-Parola, Benoit and Foret (1980) finding no difference and Meccaci and Zani (1983) and Taillard, Philip and Bioulac (1999) finding eveningness to be associated with a greater need for sleep, less time in bed during the week compared to ideal sleep needs, and more time in bed during rest days.

More recently, Putilov (1993b, 2000) has deconstructed the morningness-eveningness dimension into more specific morning and evening sub-constructs in an attempt to examine it further. Using the Sleep Wake Pattern Assessment Questionnaire (SWPAQ), M- and E-types were further separated into 8 new factors: quality of night time sleep, morning lateness, evening lateness, ability to stay awake and ability to fall asleep at unusual hours, ability to nap in the daytime, to shift sleep time, and to be more alert in the evening than the morning. Putilov tested whether the M and E scales of the SWPAQ were related to various chronobiological indexes as well as to the adaptability of the sleep-wake cycle. He found that both M and E scorers were associated with later circadian phases and a decrease in the amount of SWS. Furthermore, high M scorers were characterised by good nighttime sleep and the ability to sleep at unusual hours, whilst high E scorers had more flexible sleeping habits. In a different approach, some researchers have turned to the circadian system itself in an attempt to explain the differences in M and E-type activity. In a study of the circadian regulation of subjective alertness, Natale *et al.* (1996) argued that differences between M- and E-types may be linked to contrasting systems of regulation. Thus whilst the sleep-wake cycle (regulating parameters such as sleep timing and SWS propensity) is more important for M-types, for E-types, the endogenous circadian pacemaker (primarily regulating body temperature) is more important. Some have also suggested that genetic influences may have a significant role to play in shaping our circadian system (Wever, 1984; Kerkhof, 1985; Monk, 1988; Aguair, Silva and Marques, 1991) whereas Webb (1981) argues that the circadian system reflects an underlying 'evolutionary epistemology'.

Despite continuing debate as to the underlying explanations for phase differences, research into the morningness-eveningness dichotomy is extensive. Results have shown that M-types are more sensitive to delays in night sleep (Hildebrandt, 1986) wake earlier following morning sleep (Hildebrandt and Stratmann, 1979, Åkerstedt *et al.* 1982), show a greater detriment in indices of fitness during a night shift (Östberg, 1973), impaired psychological well-being (Bohle *et al.*, 1989), less satisfaction with nightwork (Nachreiner, 1975; Hildebrandt, 1986) and are the group most likely to leave shiftwork in favour of daywork (Åkerstedt and Torsvall, 1981; Humm, 1996). Therefore, in terms of shiftwork tolerance, E-types tend to show better circadian adjustment, suffering fewer adverse outcomes as a consequence (Breithaupt, Hildebrandt, Dohre, Josch, Sieber and Werner, 1978; Bohle *et al.*, 1989; Costa, Lievore, Casaletti, Gaffuri and Folkard, 1989; Moog and Hildebrandt, 1989). In support, Folkard and Monk (1981) found the oral temperature rhythm of E-, but not M-type, shiftworkers to show relatively good adjustment to a weekly rotating shift system. Moreover, in laboratory studies, Moog (1987) showed that E-types were better able to adjust their core temperature rhythms to a simulated weekly rotating shift system, and to nightwork, whilst M-types had difficulties in adapting to nightwork even after 21 successive night shifts. He concluded that on physiological criteria, whilst very slow rotating shift systems or permanent nightshifts were acceptable for E-types, M-types working such systems require special healthcare.

Given the frequent finding that M-types react more adversely than E-types to shiftwork involving nights, some authors have attempted to explain the underlying cause of differences in sensitivity. According to Folkard and Monk (1992) there are 3 main reasons. First is the fact that M-types find it harder to both sleep in late and stay awake at night, and so incur a sleep debt, leading to feelings of fatigue when working late or night shifts. Thus whilst the M- types' predispositions will benefit those who work a 9-5 routine, it can be detrimental for those who have to work abnormal hours. Secondly, they argue that since the natural pattern of the human circadian system is to 'free run' to around 25h a day, such a pattern would naturally lead to a tendency toward eveningness. Thus E-types may be less susceptible than M-types to entrainment by the social and physical zeitgebers surrounding them, especially if they have a particularly weak entrainment mechanism. Thirdly, because nightwork typically involves a phase delay in the time that the worker retires to bed, E-types, whose natural rhythms are already delayed, with free running cycles of around 25.5h, suffer less than M-types, who, typically having a length of 24.3h (Wever, 1979) have further to adjust. Thus, since the temperature rhythm of M-types is phased earlier than E-types, this means that M-types are better able to cope with early shifts and E-types with late shifts. Indeed, in support of this view Folkard and Hunt (2000) have argued that it seems not to be the case that E-types are better suited to shiftwork *per se* but that the distinct diurnal types have a propensity for tolerance in different types of shift systems.

Over and above the temperature rhythm and sleep/wake cycle, phase differences have also been found to be manifested in other behavioural traits, with M- and E-types characterised by different personality profiles. The majority of studies have concentrated on Eysenck's personality dimensions with the general finding that E-types tend to be extraverted and M- types tend to be introverted (Blake, 1967; Patkai, 1971a, 1971b; Folkard *et al.*, 1979; Kerkhof, 1985a; Larsen, 1985; Meccaci *et al.*, 1986; Adan *et al.*, 1990; Adan, 1992; Neubauer, 1992). This has been reinforced by research into arousal and TOD effects where introverts have shown superior performance in a variety of tasks in the morning and extraverts in the evening, suggesting that arousal is higher during the first part of the day in the former, whilst the latter are most aroused during the afternoon and early evening (Wilson, 1990). Feeling more aroused, therefore, introverts and extraverts generally prefer these specific times for their daily activity. Vidacek *et al.* (1988) examined the possibility that morningness and extraversion may interact to determine the phase of an individual's circadian rhythms. Whilst their findings lend some support to Kerkhof's (1985) conclusion that morningness is more important than extraversion in this respect, they point out that the magnitude of the phase difference associated with morningness varies according to the variable under consideration, with reliable phase differences confined to subjective ratings of alertness, oral temperature, and in combination with extraversion, choice reaction time.

Given the wealth of research showing a change in sleep-wake behaviour with ageing (Tune, 1969; Webb, 1982; Weitzmann *et al.*, 1982), the most common effect being an advanced rising time, it is not surprising to find increasing age being consistently linked with increasing morningness (Fröberg, 1977; Torsvall and Åkerstedt, 1980; Meccaci and Zani, 1983; Kerkhof, 1985b; Adan and Almirall, 1990; Wilson, 1990; Adan, 1992), with 50 appearing to be the critical point for preferences for morning behaviour (Ishihara, Miyake and Miyata, 1992). Meccaci *et al.* (1986) found a gradual shifting towards morningness in groups aged 50-79 years, amongst which the eveningness typology completely disappeared. They argue that the difficulty of older individuals to tolerate shiftwork (as discussed later) could be explained to some degree by the trend towards a morning habitual activity phase. In support, Carrier, Monk, Buysse and Kupfer (1997) examined the role of morningness-eveningness as a mediator of the relationship between age and sleep. Using adults aged between 20-59 years, increasing age was found to be related to earlier habitual waketime, earlier bedtime, less time in bed, better mood and alertness on awakening and higher morningness scores.

Continuing the theme of relationships between morningness-eveningness and other individual differences, E-types, especially males, have also been found to exhibit behavioural patterns typical of a Type A personality (e.g. impatience and competitive need for achievement), a personality trait often related to stress, and in turn susceptibility for cardiovascular problems (Nebel, Howell, Krantz, Falconer, Gottdeiner and Gabby, 1996; Meccaci and Rochetti, 1998). Moreover, although E-types tend to suffer fewer sleep and fatigue problems related to shiftwork digestive complaints are more frequent. Fröberg (1981) has suggested that this may be as a result of more irregular eating patterns, reporting that E-types tend to change their eating habits according to the type of shift worked, whilst M-types had more stable eating patterns and consequently less digestive problems (Ishihara, Miyasita, Inugami, Fakuda, Yamasaki and Miyata, 1985; Costa, Lievore, Ferrari, and Gaffuri, 1987; Minors, Rabbitt, Worthington and Waterhouse, 1989). In addition E-types have a higher consumption of alcohol and caffeine, tend to be habitual smokers (Ishihara *et al.*, 1985; Adan, 1994; Taillard *et al.*, 1999) and consume breakfast less often, but consume more during the night in comparison to M-types. On this last point it is worth noting that since M-types consume more during the first part of the day and therefore, obtain the majority of their daily calorie intake at this time, E-types, consuming most of their calories in the evening, will have a calorie shortage during the morning when labour demands are generally greater, and thus may be at a disadvantage in terms of energy, efficiency and safety.

Evidence has also suggested that morningness-eveningness can also be affected by differing levels of photoperiodicity as a result of the changing seasons. A number of studies have highlighted seasonal differences in the circadian phase of various physiological functions, although results have been mixed, with some finding a weak variation and others no variation at all (Van Dongen, Kerkhof and Souverijn, 1998). Under controlled conditions in a climatic chamber, Van Dongen, Gerard, Kerkhof and Klöppel (1997) studied the circadian phase of rectal temperature and SWS in a series of twelve 24h experiments, one for each month of the year. Although the temporal relationship of the two functions remained stable, both the rectal temperature and the onset of SWS reached their earliest phase values in the summer and latest in winter. In winter the average circadian rhythm of rectal temperature was phase delayed by 45 min, and the average onset of SWS by 40 min. Similar findings have also been derived for sleep propensity, sleep wake-up time, and plasma melatonin concentration (Wehr, Giesen, Moul, Turner and Scwartz, 1995; Emura, Kuroda, Satani, Mandai, Itaya, and Yoshida, 1996). Moreover, in studying the interaction between shift type and seasonality on the adaptation of the 6-sulpatoxymelatonin rhythm, Barnes, Forbes and Arendt (1998) found both to be important mediators in circadian phase change. More recently evidence has shown circadian typology to be modulated by the season of birth. Here a prevalence of M-types amongst those born in autumn and winter compared to spring and summer was found, whereas the opposite was true of E-types (Natale and Adan. 1999). Others still have advocated the role of genetic factors in the development of circadian typology (Fukuda, 1997).

In summary, the differentiation of M- and E-types has become a topic of systematic physiological and behavioural investigation, with many purporting the morningness-eveningness dichotomy to be predictive of performance and adaptability to non-daytime schedules such as night and shiftwork. Research in this area has been widespread and enduring, and has consistently shown distinct differences in a number of psychophysiological rhythms and responses to environmental events, such as sleep-wake behaviour, gastrointestinal function, eating behaviour, and susceptibility to CVD and stress. The culmination of research in this area has suggested that E-types are better suited to shiftwork, especially that involving nights or a phase delay, since the activity requirements are phase shifted with an individual's optimal time of day. Although the available evidence would suggest that M-types are better suited than E-types to early morning schedules, such a prediction has received little attention.

3.2.1.2. Circadian Amplitude

Since the effect of shiftwork on the human circadian rhythm is one of desynchronisation, in order to adapt to a particular work schedule, the shiftworker must go through a process of re-entrainment. Characteristic of this stage is a dramatic reduction in rhythm amplitude (the difference between the maximum and average value over a complete cycle). According to Reinberg *et al.* (1980) a person's amplitude can be used as an indicator of the speed with which the circadian rhythm will adjust to a new schedule, (i.e., how easily a worker can reset their circadian clock) and thus how well they will be able to cope with shiftwork. According to the oscillator theory, the strength of the circadian oscillator is reflected by its amplitude, so weaker oscillators may re-entrain faster, leading to greater adjustment and tolerance to shiftwork (Wever, 1965; Aschoff and Pohl, 1978).

Supporting evidence for this view can be found in a longitudinal study of students entering a rapidly rotating shift system for the first time. Vidaček, Radošević-Vidaček, Kaliterna and Prizmić (1993) found that individuals who showed a lower amplitude of 24h variations in temperature, negative moods, and fatigue, before entering shiftwork were better able to adapt to working nights after one and three years of experience, compared to those who had greater amplitudes of these variables. They, therefore, agreed with the statement of Åkerstedt and Fröberg (1976) that individuals with low amplitudes, having less to invert, adapt more easily. Conflicting evidence however, has been provided by a number of studies showing that shiftworkers tolerant of nightwork possess temperature rhythms of greater amplitude than those who find it difficult to adapt (Andlauer *et al.*, 1977, 1979; Leonard 1980; Reinberg, Andlauer and Vieux, 1981a; Reinberg, Vieux and Andlauer, 1981b; Reinberg, Vieux, Andlauer, Guillet and Nicolai, 1981c; Costa *et al.*, 1989). A possible underlying variable linked to this finding was introduced by Minors and Waterhouse (1983) who suggested that 'commitment to shiftwork' may interact with amplitude to determine the extent to which a person may adapt. In a study of the routines of nurses during their normal night duty, they found that those working only a single night shift retained diurnal habits, taking naps and snacks at the same points throughout the day, whereas those working three or more night shifts consecutively attempted to adapt by making substantial changes to their normal routine, such as taking longer sleeps after the shift and altering the time of their main meal, even if it encroached upon their leisure time. Commitment to shiftwork is discussed in greater detail later.

As with circadian phase, a number of studies have highlighted a relationship between age and amplitude, where increasing age is associated with a decrease in amplitude of oral temperature (Baehr, Revelle and Eastman, 2000). Moreover, in the same study, subjects with more delayed phases (E-types) also had large amplitudes, a finding that held across gender, although the oscillator theory mentioned above does predict such a relationship. The relationships between phase and amplitude were also addressed by Costa *et al.* (1989). Amongst nightworkers with digestive complaints, there existed a negative correlation between phase and amplitude, whereas in those subjects without complaints, a positive correlation was found.

A recent addition to this area has been the introduction of the concept of 'time awareness'. Based on the hypothesis that a better sense of time will be shown by those with high circadian amplitude rhythms, Folkard (1996) constructed the Time Awareness Questionnaire. The first, and almost exclusive, evidence of an association between time sense and internal rhythms was reported by Aschoff (1985) amongst individuals who were isolated from all time cues for several weeks. When asked to estimate the passage of time on an hourly basis, these individuals consistently exaggerated, producing intervals longer than one hour. These were positively correlated with both the duration of wakefulness and with the length of the sleep-wake cycle. Later studies by the same author reiterated and extended these findings (Aschoff, 1997, 1998a, 1998b), showing the estimation to be unrelated to either rectal temperature or light intensity. Despite such efforts, the relationship has received little attention.

At the present time only one psychometric evaluation of the Time Awareness Questionnaire has been conducted (Gomes, Silva, Clemente, Coelho, César, Pissarra and de Azevedo, 1999). Here an earlier 17-item version (containing items relating to time awareness only) was translated into Portuguese and tested on a group of students. Factor analysis extracted three structures: 'Internal time', 'Independence from a clock' and 'Flexibility/rigidity of habits', all of which showed good internal consistency. In a repetition of the study, Gomes *et al.* (in press) have further reduced the original version to 12 items. Recognising the importance of such findings to the shiftwork literature, Gomes *et al.* (1999) concluded "further research, including validity analyses and using shift work samples are needed...to examine the relationship of the Time Awareness Questionnaire with tolerance to shift work" (pp. 110). The present thesis reports the first attempt to do just this.

In summary, since the major finding of both laboratory and field studies is that shiftworkers, especially those involved in nightwork, are forced to modify their circadian rhythmicity by a reduction in amplitude, it therefore follows that if a person's amplitude is relatively small, it has less to adjust, and will do so more rapidly to a shift in routine, typically associated with shiftwork (Aschoff, 1978b).

3.2.1.3. Circadian Type

Based on the hypothesis that better adjustment would be shown by those people with low amplitude, and flexible, or non-stable rhythms, Folkard *et al.* (1979) examined the possibility that characteristics of the sleep-wake cycle itself may be applicable to shiftwork tolerance. Taking the phase and amplitude of the circadian rhythms into account, they devised a more general questionnaire than the likes of the morningness-eveningness scales that had gone before them, and instead incorporated separate scales relating to phase, amplitude and stability of circadian rhythms.

Factor analysis of the Circadian Type Questionnaire (CTQ) yielded 3 constructs. The first, termed 'Rigidity-Flexibility', described the ability to sleep at unusual times of the day. Rigid types (R) were characterised by an inability to sleep at unusual times, having difficulty getting to sleep early and sleeping in late, even when tired. Such individuals also preferred to sleep and eat at regular times and maintained their normal sleeping habits even when there was no need to (e.g., during rest days or on holiday). In contrast flexible types (F) found it relatively easy to sleep at unusual times and had no preference for regular sleeping or meal times. Furthermore, rigidity showed a positive correlation with length of experience of nightwork such that more experienced individuals appeared to have more rigid sleeping habits. It was thus suggested that this factor related to the stability or lability of an individual's circadian rhythms. The second factor was concerned with the ability to overcome drowsiness. Indicative of circadian amplitude, this was labelled Languidity-Vigorousness. Vigorous types (V) reported relatively low levels of drowsiness after reduced sleep and were able to overcome drowsiness when necessary. They were also able to miss out on a night's sleep, to be relatively unaffected by lack of sleep, and to be able to wake easily at unusual times. Languid types (L), in contrast, reported feeling very drowsy after a night of reduced sleep, finding it difficult to overcome drowsiness or to wake up properly at abnormal times. The original CTQ also had a third dimension "morningness".

In their initial study, Folkard *et al.* (1979) found that, in general, F types showed better circadian adjustment than R types, and V better adjustment than L types. The morningness scale, however, was not found to be associated with any measure of adjustment, suggesting that flexibility of sleeping habits and ability to overcome drowsiness may be more important in determining adjustment to shiftwork than the more frequently studied factor of morningness.

Evaluations of the CTQ were less positive reporting it to be psychometrically weak. Poor internal consistency between scale items and unstable factor structures were cited as the over-riding deficiencies (Smith *et al.*, 1989). Partly in response to such reviews, the CTQ was revised and renamed the Circadian Type Inventory (CTI; Folkard, 1987) and contained only the rigidity-flexibility and languidity-vigorousness scales, although again this met with similar criticisms (Silvéro, Silva and Azevedo, 1997). In a psychometric evaluation of the properties of the CTI, Smith, Brown, Milia and Wragg (1993) stated that "The CTI obviously measures something but what it is, is not clear" (pp.173) and went on to point out that there is an overlap between several items on the scale, making it ambiguous as to which factor they belong to.

They conclude that the CTI "does not appear to be a suitable tool for the sensitive and unambiguous measurement of circadian rhythm characteristics" (pp. 174). Furthermore Kaliterna, Vidaček, Radošević-Vidaček and Prizmić (1993) found the vigorousness-languidness dimension to be unstable after revealing relatively low correlations between two administrations.

Despite the psychometric analyses of the scales, both flexibility and vigorousness have been found to be related to a better long-term tolerance to shiftwork as judged by the frequency of health and sleep complaints (Dirkx *et al.*, 1987; Verhagen *et al.*, 1987; Costa *et al.*, 1989; Iskra-Golec and Pokorski, 1990; McEntee and Gallwey, 1997), with additional evidence that vigour predicts some indices of psychological well-being on night shift (Wynne *et al.*, 1986), is associated with less disruption of health, sleep, and sexual activity among shiftworkers (Folkard *et al.*, 1980) and a higher mean level, and a less steep drop, in alertness (Folkard *et al.*, 1979). Rigidity of sleep has been found to predict several indices of psychological well-being on night shift (Wynne *et al.*, 1986) and has been associated with a slower rise in alertness over the day among nightworkers (Folkard *et al.*, 1979) along with self-reports of anxiety and digestive problems (Folkard *et al.*, 1980). Using a Portuguese version of the CTI, Silvéro *et al.* (1997) found flexible workers to have less difficulty with sleep, especially when working night shifts, and better physical and psychological health, including anxiety, depression and mental illness. Furthermore, Vidaček *et al.* (1988) showed that an ability to overcome drowsiness was the best predictor of shiftwork tolerance after three years of shiftwork. In a study of stress states experienced by operators in a nuclear plant, Ognianova, Dalbokova and Stanchez (1998) found languidity to be associated with digestive, psychosomatic and mental health problems (often a result of stress states), in addition to distractibility, irritability and reduced alertness during night shift, whilst flexibility was negatively correlated with sleep disturbances and chronic fatigue. Iskra-Golec (1993) found flexibility of sleeping habits and the ability to overcome drowsiness to be the best predictors of attitude towards shiftwork in both present and former shiftworkers, but not in dayworkers without shiftwork experience, leading them to postulate that the relationship may be formed as a result of the experience with shiftwork and its concomitant effects.

In a study of shiftworkers' motivation for certain shift patterns, Humm (1996) investigated the difference between two groups of nurses, those who would choose nights and those who would not, all of whom worked night duty as part of their shift pattern. The group who would not choose nights were found to be more languid and less flexible than those who would, with the largest statistical difference between the two groups being on the flexibility/rigidity construct. In line with this, those who were found to be more languid and flexible also showed lower shiftwork tolerance in terms of physical and psychological health measures. This led him to conclude that, since nightworkers have to revert to a daytime routine on their rest days, flexible sleeping habits would be a beneficial attribute during periods of short-term adaptation.

In summary the evidence to date suggests that, despite doubts as to the reliability of the scales, a person who is flexible in their sleeping habits and vigorous in their ability to overcome drowsiness will suffer fewer problems as a result of working shifts than an individual who is categorised as being rigid and languid. This supports the original conception of Folkard *et al.* (1979) in predicting that greater shiftwork tolerance will be shown by those people who are able to adapt their behaviour to a change in routine and show low amplitude and more flexible or non-stable rhythms.

3.2.2. Personality

3.2.2.1. Extraversion-Introversion and Neuroticism-Stability

As has been discussed in relation to circadian phase, the personality constructs of introversion-extraversion and neuroticism-stability have been implicated as factors affecting a worker's adaptation, and subsequent tolerance to, shiftwork. Reliable differences in the circadian rhythm characteristics of introverts and extraverts have been found with the general agreement that introverts have an earlier phase position than extraverts with regard to the rhythms of sleeping and waking, body temperature and performance (Blake, 1967; Vidacek *et al.*, 1988) making them less well suited to shiftwork, especially that involving nights. This has been confirmed by evidence showing introverts as reporting more frequent problems with psychological health, distress, musculoskeletal complaints and fatigue (Singer and Levens, 1990). Furthermore, neurotics have been found to show spontaneous internal desynchronisation of their circadian rhythms more frequently than stable individuals (Lund, 1974).

Other studies have built upon this line of research and found that differences exist in terms of the rate with which rhythms of the different personality types re-entrain following a change in shift schedules, or in the course of adaptation to shiftwork. For example, Colquhoun and Condon (1980) found circadian adjustment to nightwork to be significantly faster in extraverts compared to introverts. By the 11th or 12th successive shift, the sleep-wake cycle of the former, but not the latter, was completely adjusted. Taking a more orthogonal approach, Colquhoun and Folkard (1978) found a tendency for neurotic-extroverts to show better adjustment of the temperature rhythm in both jet-lag and shiftwork situations when compared with neurotic-introverts. Thus in situations where phase adjustment occurs, such as in slowly rotating shifts, neurotic-extraverts would be expected to cope more easily and show fewer adverse effects. In support, Monk and Aplin (1980) also found that neurotic introverts were less able to cope with changes in daylight saving time.

Much debate surrounds the construct of neuroticism throughout the shiftwork literature. Based around the question of cause and effect, some studies have found it to be a moderator of shiftwork related problems, whilst others have found it to be an outcome. For example, using personality variables to classify attitudes towards shiftwork amongst groups of shiftworkers, Nachreiner (1975) found those who scored highly on the neurotic scale tended to complain most about the effects of shiftwork and, consequently, were the ones most likely to transfer to daywork. Similarly, Åkerstedt (1980) found neuroticism to be a strong predictor of self reported symptoms amongst regular nightshift workers, whilst Humm (1996) reported those who would choose to work nights, if given the choice, scored lower on neuroticism. Vidaček *et al.* (1987a) showed neuroticism to be related to impaired subjective health after 3 years of shiftwork and not before, whilst Bohle *et al.* (1989) found it to be a predictor of psychological well-being before and after 6 months but not after 15 months on shifts. Thus, in these studies neuroticism has been suggested to be a consequence of shiftwork tolerance rather a predictor and, to this effect, has been included as an outcome measure of shiftwork problems by some authors (Barton and Folkard, 1993) as it is in the present thesis. Despite the wealth of evidence supporting this conclusion it is important to note the lack of convincing evidence that shiftwork *per se* makes people more neurotic within the first years of shiftwork, since none of the published longitudinal studies have had a control group of dayworkers as a comparison (Meers *et al.*, 1978; Vidacek *et al.*, 1987; Bohle *et al.*, 1989; Iskra-Golec, Marek, and Noworol, 1995). However, on the strength of evidence available to date the general assumption would be that a person who is extraverted in personality and emotionally stable, will be better able to tolerate shiftwork than one who is introverted or neurotic.

3.2.2.2. Locus of Control

Although the concept of attributional style is not new, Locus Of Control (LOC) can be regarded as one of a new breed of personality dimensions recently introduced to the field of shiftwork. LOC was the original conception of Rotter (1966) and refers to the pervasive tendency to attribute the source of control over outcomes, rewards and reinforcements in a particular manner. Individuals with an internal LOC have high levels of perceived control and believe the reinforcements they receive to be contingent upon the behaviours and attributes they bring to the situation. In contrast, those with an external LOC have low levels of perceived control and believe outcomes to be contingent upon outside forces, fate or other people.

LOC has been regarded as an important factor that may promote or hinder good health behaviours in particular. According to the reformulated learned helplessness model of depression (Abramson, Seligman and Teasdale, 1978), internals who attribute negative events to personal, global and stable causes are predisposed to depressive symptoms (Sweeney, Anderson, and Bailey, 1986; Brewin, 1988; Robins and Hayes, 1995), whilst paranoid patients have been found to make external, global and stable attributions (Kany and Bentall, 1989; Candido and Romney, 1990; Lyon, Kany and Bentall, 1994; Kinderman and Bentall, 1996). A review by Strickland (1978) concluded that an internal attributional style was generally associated with fewer health problems, a finding corroborated in an earlier argument by Kirscht (1972 cited in Smith, Spelten and Norman, 1995) that beliefs in controllability should correlate with beliefs that health problems may be overcome. Internals should therefore show behaviours aimed at preventing or reducing problems and seeking out information about tackling and preventing them.

However, such conclusions are made difficult by the fact that the majority of studies have used a general LOC measure rather than attempting to tap into more specific areas. Yet, since LOC is a personality attribute that determines how a person appraises a situation, its relevance in predicting behaviour may change depending on the area concerned. This recognition has led to the creation of more domain specific measures, with scales designed to explore the effect of LOC on work behaviour (Pettersen, 1985; Spector, 1988), economic behaviour (Furnham, 1986), and health behaviour (Wallston, Wallston, Kaplan and Maides, 1976; Coelho, 1980; Eiser, Eiser, Gammage and Morgan, 1989; Roberts and Ho, 1996). Such scales have generally been considered to be more effective measures in specific situations when compared to the general original scale of Rotter (1996).

In relation to the occupational setting, Spector (1982) has provided evidence that internals suffer fewer job-related problems because, believing that their own actions affect the outcome of situations, they are more inclined to gain control over a range of features, including work flow, task accomplishment, goal setting, operating procedures, work assignments, interpersonal relationships, working conditions, organisational policy and work scheduling. Spector also found internals to perform more effectively than externals, to seek more relevant information, put greater effort into completing their work tasks and were generally more careful in the execution of their duties. Indeed, personal control in shiftwork situations can have a significant role in moderating the adverse effects of a dysrhythmic work schedule. This is supported by evidence showing that the amount of control over the number of work hours can affect the shiftworker's rating of shiftwork tolerance (Barton, Smith, Totterdell, Spelten and Folkard, 1993).

Building upon these findings, Smith, Spelten and Norman (1995) set about developing the Shiftwork Locus Of Control (SHLOC) scale to examine an individual's response to four problem areas most commonly associated with shiftwork: sleep, social life, health and work. During the development of this scale they found SHLOC internality to be associated with those variables previously considered to be linked to greater shiftwork tolerance and safer performance, such as alertness, flexibility of sleeping habits, ability to overcome drowsiness, perceived control of work hours and a more structured use of time. Furthermore, compared to low internals, high internals reported experiencing fewer shiftwork-related problems and better psychological health. Thus, although research using this dimension is not extensive, it is believed that personal control in shiftwork is a major influence in the moderation of its adverse effects. Based on the available evidence, internals should make better shiftworkers, in that they perceive themselves to be responsible for the outcomes of situations and are more attuned, and perhaps willing, to take action to minimise the negative impact of shiftwork on life domains.

3.2.2.3. Hardiness

Although research to date has yet to firmly establish whether it should be regarded as a personality measure, a behavioural style, a coping strategy, or simply a consequence of the stress of shiftwork, hardiness has been introduced as a new variable associated with shiftwork tolerance, and one closely linked with LOC. Indeed, both have been found to buffer the effects of stress on illness (Lawler and Schmeid, 1992). According to Funk (1992) hardiness is the general feeling that the environment is satisfactory, resulting in an individual approaching situations within that environment with curiosity, enthusiasm and engagement. Thus, hardy individuals should approach shiftwork with a sense of challenge and commitment, addressing the problems they suffer and thereby, adapting to their work pattern more successfully. Wedderburn (1995) suggested that hardiness might provide the 'missing link' between personality and adaptation to shiftwork. In a study of rotating shiftworkers, he tested the hypothesis that a hardy attitude toward shiftwork might underlie the healthy shiftworker effect. Whilst a liking for shiftwork was correlated with hardiness, great emphasis was put on the need to establish cause and effect. Furthermore, Manning, Williams and Wolfe (1988) concluded that hardiness failed to moderate the relationships between stressors and outcomes, although it was found to have significant direct effects on emotional and psychological factors related to personal well-being and work performance. Hardy individuals reported higher levels of job satisfaction and fewer tensions at work.

Although there remains a paucity of research on the dimension of hardiness, in part due to the suggestion that scales of hardiness inadvertently measure the personality dimension of neuroticism (Costa and McCrae, 1985, 1987), Wedderburn concluded that "It looks to be a useful tool for exploring the problems and solutions of shiftworkers" (pp. 209).

3.2.3. Demographical

3.2.3.1. Age and Shiftwork Experience

Research has demonstrated several age dependent differences in shiftwork tolerance, with many studies showing a definite worsening of problems in those aged 40-50 years (Åkerstedt and Torsvall, 1980; Foret *et al.*, 1981; Koller, 1983; Ishihara *et al.*, 1992; Brugère, Barrit, Butat, Cosset and Volkoff, 1997; Nakata, Haratani, Kawakami, Kurabayashi and Shimizu, 2000), although Oginski *et al.* (1993) suggest that the effects may be gender specific, noting a decrease in complaints amongst women aged 50 years or above. Nevertheless, this critical turning point is thought to be influenced by changes in both the sleep-wake pattern and circadian rhythmicity typical of this age group.

Sleep has been found to be age specific in terms of the changes that occur in a person's sleep-wake pattern as they get older. According to Haimov and Lavie (1997) changes in the sleep-wake pattern are among the hallmarks of biological aging, whilst Gillin (1985, cited in Atkinson, Atkinson, Smith and Bem, 1993) states that a natural kind of insomnia seems to set in as people grow older. Indeed, the sleep pattern of older individuals is often classed as being fragile in comparison to younger age groups, and is characteristically shorter in length, of poorer subjective quality, more easily disrupted and lighter, with an increase in the number and duration of awakenings (Miles and Dement, 1980). Moreover these effects have been found to be true for both shiftworkers and non-shiftworkers (Brugère *et al.*, 1997). However, certain sleep problems such as difficulties falling asleep and early awakening have been found to peak in subjects aged 52 and then decrease at 62 years of age, which some authors suggest may be the result of a 'retirement effect' (Marquie and Foret, 1999).

A distinction has been made between day and night sleep of older versus younger shiftworkers. In a comparison between the two, Åkerstedt, Torsvall and Gillberg (1982) concluded that older workers showed longer sleep lengths before a morning shift, whilst day sleep following a night shift was truncated. In an earlier study, Torsvall *et al.* (1981) compared the physiology of sleep in the young and old and found the day sleep of the latter to be characterised by a higher proportion of Stage 1 and stage shifts, as well as elevated levels of urine and noradrenaline excretion. In support of these findings, Mulder, Rosa, Härmä and Näsman (1994) reported that before a morning shift, older workers fell asleep more easily, slept for longer and rated their sleep quality as higher than younger workers. As a result the former also rated themselves as feeling less tired. Although subjective ratings of sleepiness did not differ between groups following a night shift, sleep in the older age group tended to be truncated.

The effect of the number of consecutive night shifts worked has also shown differences with age. In laboratory conditions, Härmä, Hakola, Åkerstedt and Laitinen (1994) found that during the first simulated night shift, younger workers were comparatively more sleepy than older shiftworkers, but noted that by the third night shift, the opposite was true, with older shiftworkers rated as more sleepy. Although sleepiness tends to increase in this way, evidence has suggested that it is the young who are more sensitive to sleep loss. Monk, Buysse, Reynolds, Jarrett and Kupfer (1992) showed that, in comparison to young people, the performance over 24h, mood and activation of elderly people did not decrease as much during the night hours.

In addition to these changes in sleep-wakefulness, there is also the question as to whether there are also relevant circadian changes with age that would influence shiftwork tolerance. Chronobiologically, ageing has been found to be associated with a tendency for internal desynchronisation of the endogenous and exogenous rhythms making entrainment after a change in routine difficult to achieve. Coupled with the fact that ageing is associated with a flattening in circadian amplitude (Van Gool and Mirmiran, 1986; Haimov and Lavie, 1997) linked to the speed with which entrainment can take place, evidence suggests that older individuals may encounter more problems as a result of working shifts, especially in rotating patterns that require a constant readjustment in routine. This has been corroborated by evidence from indirect cross study comparisons showing that, compared to younger people, the circadian rhythms of older individuals, especially the middle aged, are more protracted in their ability to adjust following a change in routine (Moline *et al.*, 1991). However, the association between age and reduction in circadian rhythmicity has been questioned by studies that have found no such effect (Monk, Buysse, Reynolds, Kupfer and Houck, 1995, Monk *et al.*, 1995) begging the question of how age influences shiftwork tolerance and whether the influence holds for all people.

Concomitant with these findings is the link between age and morningness (e.g. Kerkhof, 1985a, 1985b). In a study of circadian activity in healthy young and elderly individuals, Lieberman, Wurtman and Teicher (1989) found elderly people (>65) to reach their circadian peak of activity approximately 2h phase-advanced compared to younger subjects. Furthermore, Monk *et al.* (1991) found that of 30 youths tested on the MEQ only one was above the threshold for morningness, whilst not a single member of the older group gained a score below this. Similar results have been found irrespective of the questionnaire employed. In an extensive review of the morningness dimension, Tankova, Adan and Buela-Casal (1994) highlight the fact that those studies that have failed to find an association between age and morningness present one of two common problems. They point out that such studies have either used a student, rather than a shiftworker cohort, or that the cohort have been under the 'critical age' of 50 years, when the majority of problems have been shown to occur. Despite such criticisms, the fact that advanced age is associated with morningness may help to explain why, as aforementioned, older workers experience sleep problems following a night shift compared to a morning shift, since M-types typically find it difficult to sleep in late during the day, preferring to get up early in the morning and retire to bed early in the evening. On the other hand, based on their circadian characteristics, M-types are well suited to morning shifts since it necessitates an early bedtime and an early start to the day.

A further point that deserves attention is the possible additive effect of shiftwork experience. Older shiftworkers, having generally had more experience with shiftwork-related problems, are thought to have the advantage of having built up effective coping strategies along the way. Coupled with the fact that older people generally have better housing conditions, more free time and fewer responsibilities, with children having grown up and left home, the adage that 'with age comes experience' should be a positive one in terms of adaptation to shiftwork. However, this is not necessarily the case, with a number of studies suggesting that shiftwork may have adverse health effects on older individuals. For example, in a study of the health of permanent shiftworkers, dayworkers and those that had left shiftwork, matched in age and work experience, Koller (1983) found a sharp increase in sleep disturbances, gastrointestinal and cardiovascular disorders, and absence from work due to sickness, in a group of workers on a permanent cycle, after the age of 40-45 years. However, an additional influence in this respect may be the coping strategies that older individuals evolve over their working lives. These strategies, if rigid, can prove to be very difficult to change and may require a huge amount of effort and commitment on the individual's part if adjustments need to be made. Thus, because older people are generally less flexible, both mentally and physically, the capacity of those unfamiliar with a change in shift schedule, or shiftwork in general, may be reduced.

In conclusion, although it is generally thought that the older shiftworker will be better prepared for shiftwork, the physiological changes that are concomitant with advanced age may influence their adjustment. A change in sleeping habits and circadian rhythmicity are typical of the ageing process and tend to be more pronounced in those ranging from 40-50 years of age. In terms of the selection for employment, based on the findings to date, a person's age may render them unsuitable for work involving shifts and may prove to be a more important factor than qualifications or experience.

3.2.3.2. Gender

Differences between males and females are rife in most branches of psychology with divergent findings evident on a number of environmental, physical, behavioural, mental, and cognitive dimensions. Although gender has not received the same amount of attention within the body of shiftwork literature, it has nevertheless been shown to be an important factor in shiftwork tolerance and, as such, is the subject of much debate.

The earlier retirement age for women, in combination with legislation prohibiting women's nightwork in a number of countries, suggests that females may be more at risk as a result of working shifts. Such legislation has important implications for both gender-related selection criteria and health and safety regulations. On one hand the principle of equal treatment for males and females had been posited as a reason in favour of its removal, whilst on the other, evidence from research showing women to be less shiftwork tolerant argue in favour of upholding the ban. The majority of these studies have concentrated on the differences between males and females in sleep characteristics, health complaints, domestic responsibilities, and stress and burnout.

In terms of sleep, it has been suggested that women have a longer habitual sleep need (Oswald, 1966), where, in free-running studies, Wever (1979) found women to need approximately 90 minutes more in comparison to men. However, the fact that women require more sleep does not necessarily mean that they obtain it. In fact several studies have shown the sleep of women to be deficient in terms of both quantity and quality, often characterised by frequent awakenings, difficulties in sleep propensity (Epstein, Tzischinsky, Chillag and Lavie, 1990; Oginska *et al.*, 1993; Middlekoop, Smildevandandoel, Neven, Kamphuisen and Springer, 1996; Park, Matsumoto, Seo, Shinkoda and Park, 1998), and tiredness upon waking (Estryn-Behar, Gadbois, Peigne, Masson and Le Vall, 1990). Perhaps, as a consequence, women have also been found to rely on sleeping pills to a greater extent than males (McGhie and Russell, 1962; Epstein, *et al.*, 1990).

In a study of gender differences in the sleep behaviour of shiftworkers, Oginska and Oginski (1990) found the average length of sleep to be comparable in morning and afternoon shifts, but severely reduced in females following the night shift, sleeping, on average, an hour less than males. As a consequence women also tended to rely more on afternoon naps, especially following a morning or night shift. The situation was reversed on rest days where females slept for longer (9h 04mins compared to 8h 11mins). Since long sleepers are classed as those who require 9h or more in order to feel refreshed, such a finding lends support to the theory that women are, by nature, habitually long sleepers. When asked whether they felt they had obtained sufficient sleep, women consistently answered more negatively across all shift types and days off. In terms of the quality of sleep, women complained more of frequent and premature awakenings and feeling tired upon waking, and as a consequence, women were also found to suffer greater feelings of drowsiness during work hours. In an earlier study, Lavie *et al.* (1989) showed that the combination of difficulty falling asleep and frequent mid-sleep awakenings, especially after the night shift, could be used as markers for a 'general maladaptation syndrome' to rotating shiftwork. Using this as a basis, Epstein *et al.* (1990) found that three-fold more women than men working a rotating shift pattern were defined as maladapted.

Such findings have led to the question of whether women are naturally predisposed to poorer sleep or whether other factors may adversely affect their sleep-wake cycle. Differences in temporal organisation of circadian rhythmicity have been purported as one explanation (Freeman *et al.* 1934) with evidence suggesting that females, rather than males, may be more prone to various circadian rhythm disorders. Wilson (1990) found women to have a higher diurnal rhythm of skin conductance until 10:00am with men being higher thereafter, whilst Moe, Prinz, Vitiello, Marks and Larsen (1991, cited in Tankova *et al.*, 1994) found both a higher amplitude and a phase advance of around 49min in the core body temperature of females, in comparison to that of their male counterparts. Women also tended to retire to bed and rise earlier than men. Under internally synchronised conditions, Wever (1984a) found the free running period of females to be 28min shorter than that of males. He also found a shortening of the sleep-wake cycle to be typical of desynchronisation in females, whilst males were characterised by a longer cycle. Such a difference between the sexes appears to be specific to the sleep-wake cycle, since no such difference was found in the period of their free-running temperature rhythms.

As we have seen above, a shortening of the cycle is typical of morningness and therefore, might be taken to suggest that females have a tendency toward morningness (Wever, 1984b; Kerkhof, 1985). This would certainly help to explain their frequent awakenings and problems getting to sleep following a night shift. Curiously studies examining the morningness-eveningness dimension have been inconsistent in this respect, with scores on such measures found to be independent of gender (Posey *et al.*, 1981, Kerkhof, 1985b; Meccaci *et al.*, 1986; Wilson, 1990; Adan *et al.*, 1991, Adan, 1992). After finding the phase position of women to be advanced by no more than 1h in comparison to men, Buela-Casal (1990) argued that such a difference may be too small to be detected by traditional diurnal type questionnaires. A final point with regard to circadian rhythms was highlighted by Ambert (1976) who noted that men and women differ in their response to social signals. Since such signals commonly act as zeitgebers, gender related differences in reactions to social cues may help to explain the noted differences in entrainment.

Perhaps as a consequence of the difficulties often experienced by women in their sleep-wake cycle, female shiftworkers have also been found to suffer poorer health in comparison to their male counterparts. For example, Oginska *et al.* (1993) found women to more frequently report psychoneurotic, digestive, and circulatory complaints, in addition to symptoms of chronic fatigue. Women in this study also tended to feel ill and visit their doctor more frequently, and take home medications to a greater extent than males. Singer *et al.* (1990) found similar results, with women reporting more frequent respiratory and gastrointestinal problems. Furthermore, Costa, Micciolo, Bertoldi and Tommasini (1990) compared absenteeism rates in male and female shiftworkers and dayworkers. In both cohorts, women presented a significantly higher absenteeism for illness, whereas males tended to present a higher absenteeism rate in relation to work accidents. Whilst the authors noted that this was partially connected to the reproductive activity of women, females also tended to show higher levels of morbidity, despite this fact. In relation to work experience, contrary to male nurses whose sickness rates became stable after 5 years of work, female nurses evidenced a progressive increase. This led the authors to conclude that the impact of shiftwork is more stressing among women than men, particularly during the first years of shiftwork, and the higher absenteeism rates for women can be attributed to more interference in the adaptation phase.

This last point raises the question of possible gender-related differences in coping with stress, a topic that has received considerable attention. According to a review by Weidner and Collins (1993) women are better adjusted than men when exposed to stressful events, especially when these events are over extended periods. In a comparison of coping strategies in everyday stressful situations and during missile attacks in the Gulf War, Ben-Zur and Zeidner (1996) found women to utilise a wider range of coping mechanisms in comparison to men, and were more likely to report using active, problem-focused strategies. Men, on the other hand, were more emotion-focused in their approach. This contradicts the so-called socialisation hypothesis contending that men and women are brought up and educated to cope differently to stress. Women are typically socialised to be supportive, to express their emotions openly and to seek social support from others. In comparison, men are discouraged from seeking support and are instead expected to be independent, rational, and ambitious, taking a more instrumental approach and employing problem-focused strategies. Whilst some findings have supported this theory (Pearlin and Schooler, 1978; Folkman and Lazarus, 1980; Billings and Moos, 1981; Brems and Johnson, 1989; Carver Scheier and Weintraub, 1989; Ptacek, Smith and Zana, 1992) others have refuted it (Folkman *et al.*, 1980; Heppner, Reeder and Larson, 1983; Rosario, Shinn, Morch and Huckabee, 1988).

An alternative to this theory is the role constraint hypothesis. Underlying this is the assumption that men and women differ in their social roles and, consequently, are exposed to different stressors. In other words, men and women do not differ in their *ability* to cope but instead differ in the *types* of life stresses they experience. If this is true, when exposed to the same stressor then, males and females should respond in a similar way (Rosario *et al.*, 1988). In an attempt to control for the possible effects of event type on gender differences in coping, Ptacek, Smith and Dodge (1994) asked participants to give a 5min lecture to several research assistants. Although men and women appraised the lecture situation similarly, had comparable pulse rates, and rated the lecture as equally stressful, women tended to seek social support and employed emotion-focused coping to a greater extent, whilst men used more problem-focused strategies. Such results were obviously consistent with both the role constraint, and socialisation, hypothesis of coping.

In terms of the types of stressor, Kandolin (1993) studied levels of stress and burnout amongst male and female nurses working with the mentally handicapped. Whilst there was no difference in the symptoms of stress and burnout between the two, the conditions leading to stress symptoms did differ. For men the quality of work, mainly relating to high levels of time pressure and interpersonal conflict (in the form of a higher exposure to violence and aggressiveness in their patient contacts), but not the shift schedule itself, were more often reported, whilst for females, both the working conditions and the shift schedule were mentioned. In terms of the coping strategies used, both males and females used active coping in the form of physical exercise, but women did so to a greater extent. Alcohol use was also more common in men. No differences were noted in the use of cognitive, emotion based strategies. Again this supports the role constraint hypothesis.

Whilst studies comparing males and females engaged in work of a similar workload have not found differences in shiftwork tolerance (Beerman, Rutenfranz and Nachreiner, 1990; Olsson, Kandolin and Kauppinen-Toropainen, 1990), where differences have been noted, the role constraint hypothesis is favoured as an explanation. Translated into the so-called 'double-burden' (but also termed, by some, as the 'socially-transmitted handicap', Beerman *et al.*, 1995) argues that due to the uneven distribution of domestic responsibilities between males and females, women are exposed to a greater work/non-work conflict and suffer more stress as a result. The literature therefore argues that it is not shiftwork that presents the greater risk to women, but the double burden of having to juggle responsibilities and expectations at home and at work that is often mistaken as an inability to cope with shiftwork. In support, research showing women to be less tolerant to shiftwork have found that they experience a greater number of domestic responsibilities and, therefore, demands upon their time (Gadbois, 1981;

Makowiec-Dabrowska, 1990; Oginski, Kuleta, Pietsch, Oginska and Pokorski, 1990; Robson and Wedderburn, 1990; Kandolin, 1993; Beerman *et al.*, 1995; Spelten *et al.*, 1995). Oginska *et al.* (1993) noted a change in the traditional male and female roles with women now tending to take the role of the breadwinner. The same study examined gender differences in reasons for undertaking shiftwork and found that 52% of women chose shiftwork because it offered the possibility of reconciling the demands of family and work, whilst the largest group of men (42%) started to work shifts because they had no other choice of getting a well-paid job in the locality. Furthermore, Beerman *et al.* (1995) found off the job workload to be the most important discriminating variable separating stress in men and women performing the same job and working the same shifts under the same or comparable conditions.

Presser (1990) points out that too many studies are quick to point out the disadvantages of shiftwork but much slower in identifying possible advantages. In an examination of the economic and demographic characteristics of female nightworkers in the US, women with school age children were more likely to work fixed night shifts because it allowed them to work when the children were sleeping, in addition to providing for them financially. Thus, rather than accepting shiftwork as just 'part of the job', women are tending to use such schedules to their advantage in order to cope better with their responsibilities. Indeed, Robson *et al.* (1990) found an "optimistic use" of shiftwork by married women which, when combined with strong coping strategies, allowed them to combine work and domestic commitments. This is further corroborated by the fact that, although women are generally less shiftwork tolerant, they are not necessarily in favour of giving up shiftwork for daywork. Oginska *et al.* (1993) showed that almost half of males sampled (48%) wanted to leave shiftwork compared to only 28% of females. Furthermore, whilst women in this study were found to suffer more illness, they did not perceive work as being a negative influence on their health and, in fact, were more likely to stress the positive effects of their shift schedule.

Despite such advantages of shiftwork for the female population, the extent to which the double burden affects the ability of women to tolerate shiftwork has been questioned in the light of conflicting findings which, whilst identifying the double burden, have found no adverse consequences in terms of the ability of female shiftworkers to cope. Kandolin (1993) failed to find the double burden reflected in the degree of burnout and stress that females experienced. Likewise Beerman *et al.* (1995) concluded that the double burden did not result in more severe psychosocial or subjective health impairments in women compared to their male counterparts, whilst Beerman *et al.* (1990) found no differences between male and female shiftworkers concerning subjective health, life satisfaction and satisfaction with leisure time. Epstein *et al.*

(1990) found the profile of the non-adaptive shiftworking woman to be young, single and without children, quite the opposite of the more typical ideal.

In contrast to this, Spelten *et al.* (1995) found that domestic commitment (defined as the number of dependants in the household and the level of perceived conflict between work and home) reduced both the quantity and quality of sleep obtained by female nurses and lowered subjective ratings of on-shift alertness. Beerman *et al.* (1990) found that in addition to leisure time being reduced in nurses with children, their sleep also tended to be reduced in comparison to childless nurses, (Knauth and Rutenfranz, 1981; Kolomadin-Hedman *et al.*, 1985; Gersten, 1987) especially during the afternoon shifts, when mothers typically have to truncate their sleep length and rise early to tend to the children (Gadbois, 1981). Makowiec-Dabrowska (1990) discusses the interaction between the duration of sleep, shift type, age and the age of dependants, and notes that duration of sleep of mothers increases as children grow. This may help to explain why, in a later study, Oginksa *et al.* (1993) found indices of physiological and psychological health improve after the age of 50, since it may coincide with the time at which children grow up and move away from home.

Despite the extensive interest in this area males have often been omitted from important lines of research, such as reproductive health or the double burden. Whilst it may the case that even today, in the 21st century, there still remains an unequal distribution of domestic responsibilities between the two sexes, with the onus often being on the women to provide for and nurture the family, there are also many instances of males finding themselves in the same situation. However, research has failed to compare the two in examining the impact of shiftwork in terms of the work/non-work conflict. Additionally, as can be seen from many of the studies mentioned, most have used male and female cohorts that are not strictly comparable. The majority of women shiftworkers are concentrated in the health sector, and thus hospitals present a useful opportunity to study the effect of shiftwork on women. However, with the exception of nurses, females have been scarcely discussed throughout the literature. Epstein *et al.* (1990) argue that nurses are not representative of the shiftworking population since, in comparison to the schedules employed in more industrialised settings (which incidentally hold the concentration of male shiftworkers) those used in the nursing community tend to be less rigid and organised. In order to compare purely gender-related effects of shiftwork tolerance, research must examine men and women performing the same job, working the same shifts under the same or, at the very least, comparable conditions, in an attempt to eliminate possible confounding variables. Of course, even if this were to be achieved, there still remains the argument that gender differences reflect not only biological and psychological differences but also psychosocial differences, and therefore it is extremely difficult to separate workers from their family and social contexts in order to study purely gender related effects (Oginska *et al.*, 1993).

Such arguments will undoubtedly continue to stimulate debate, as does the question regarding the justification of legislation prohibiting women from nightwork and the earlier retirement age. Evidence to date, over and above possible design flaws, has been mixed, with some studies finding a more adverse effect for women and others finding no difference at all. Despite the lack of comparable evidence in males, however, evidence on the harmful effects of shiftwork on reproductive health and the work/non-work conflict in females tend to be in favour of upholding the ban, especially in the special case of protection during maternity. Although "for women nightworkers with family responsibilities accomplishment of off-the-job tasks takes priority over daytime sleep" (Gadbois, 1981, pp. 226), and "time not devoted to work and sleep is usually filled with housework" (Makowiec-Dabrowska, 1990, pp. 109), it appears that women make an optimistic use of shiftwork, giving them the opportunity to cope better with their family responsibilities. In this respect then, the justification of such a ban is called into question. Furthermore, since there is a lack of comparable research in this area, conclusions regarding gender differences in the ability to tolerate shiftwork should remain cautionary and tentative, for it is not yet clear whether the differences reflect pure gender effects, the fact that men and women are exposed to different types of shiftwork, or whether other factors, such as psychosocial variables, may exert a fundamental influence.

3.3. Work Related Factors

The relationship between job and life satisfaction is a topic of much interest throughout the shiftwork literature, with attempts to identify the features of jobs that enhance or diminish psychological well-being in order to change occupational environments which are psychologically undesirable. While a number of studies argue that the two are positively related, others have reported an inverse relationship, and others no relationship at all (Judge and Watanabe, 1994).

In general, job stressors have been implicated in the aetiology of psychological health, physical health, and health related behavioural outcomes (Cooper, Russell and Frone, 1990). Fletcher (1991) predicted that work factors have a major influence on cognitive architecture with consequent effects on disease likelihood and life expectancy, and the Health and Safety at Work Act (1974) contains provisions to prevent 'mental injury' at work. Although not all occupational stress can be avoided, knowledge of job factors that are stressful raises the possibility of redesigning jobs and implementing stress-management interventions. Moreover, job satisfaction, health complaints and absenteeism are important phenomena, not only for workers but for the health of the companies employing them. According to Marmot (1999) there may be no trade-off between the health of workers and the health of an organisation.

Workers with a consistently high workload report greater symptoms of stress, practise poorer health habits and sustain more health risks (Repetti, 1993b). Work overload has also been related to fatigue and an inability to relax (Cooper and Sloan, 1985). Indeed, the link between workload and health is epitomised in the phenomenon of *karoshi*, being most prominent in Japan, a country notorious for its long working hours, work weeks and lack of vacations. Evidence of a more widespread occurrence is provided by a longitudinal study by House, Strecher, Meltzner and Robbins (1986) who found mortality to be three times higher amongst those with moderate to high baseline levels of job pressure, when followed up after 1-3 years. Research also suggests that supervisors and managers may be at an increased risk, since a combination of high workload and a responsibility for people has been associated with greater stress (Cobb, 1976). At the opposite end of the scale is work underload as illustrated by Frankenhauser (1975). In a study of workers in a Swedish sawmill, those who performed dull, repetitive work, characterised by little control over job pacing but the need for decisions to be made quickly, were found to have high levels of catecholamines, rates of headaches, blood pressure and a higher incidence of gastrointestinal disorders.

The importance of perceived control in the field of occupational stress has received considerable attention. In a meta-analysis, Spector (1986) reported significant correlations between perceived control and both job stressors (e.g., role conflict and role ambiguity) and job strain (e.g., job satisfaction, symptoms and emotional distress). Such findings are complimented by studies showing a positive effect of increased control. For example, McGlone and Chenoweth (2001) found job control to be the most powerful predictor of job satisfaction. In an examination of the consequences of increasing the control that lower-level production employees had over their work tasks and interrelationships, Wall and Clegg (1981) redesigned their jobs such that responsibilities were shifted from supervisors to teams of shop-floor workers. Workers were given control over the pacing of their work, the distribution of tasks between themselves, and the general organisation of their time and effort. Such changes increased the scope of the workers decision making, as well as introducing wider opportunities for skill use, more work variety and more constructive interpersonal contacts. Surveyed before the changes took place and 6 and 18 months later, employee well-being increased substantially as a result of the experimental changes, with overall job satisfaction being significantly greater and psychological distress significantly reduced. Such effects also translated to the site as a whole, with the atmosphere becoming more relaxed, fewer conflicts and less strain. Work performance and motivation also significantly increased. Marmot (1997) concluded that occupations characterised by low control were associated with increased CHD mortality, whereas those characterised by high demand were not. Furthermore, in an earlier study, Marmot and colleagues confirmed this, finding low control, but not high demand at work, to be associated with increased incidence of CHD. Low control was also associated with higher plasma fibrinogen concentrations, a known risk factor in the likelihood of heart attack.

A number of attempts have been made to conceptualise the relationship between job satisfaction and manifestations of stress. According to the Job Demand-Control (JD-C) model of Karasek (1979) adverse psychological and physiological reactions are affected by the combined impact of two structural conditions of the work environment. Here a job characterised by high demands (workload pressure) and low control (decision latitude and skill utilisation) can result in psychological strain and physical illness. Several lines of evidence have found high job demands to be associated with high emotional exhaustion (Rafferty, Friend and Landsbergis, 2001), and can be mediated by high levels of control. However, whilst job demands have been shown to be a stronger predictor than control for emotional exhaustion, the latter is stronger in the prediction of depersonalisation and reduced personal accomplishment (de Jonge and Kompier, 1997). Likewise, Holmann, Heuer and Schmidt (2001) showed control to buffer the effects of high psychological demands but not of high workload. A more recent examination of the factorial structure of the model demonstrated a better fit with a three-factor solution (job demands, skill discretion and decision latitude; Schreurs and Taris, 1998).

Meanwhile, the Effort-Reward Imbalance (ER-I) model of occupational stress defines threatening job conditions as a mismatch between high workload and low control over long-term rewards (Siegrist, Peter, Junge and Seidel, 1990). Within this model effort is conceptualised as either extrinsic (the demands of the job) or intrinsic (immersion in the job). Reward includes concepts such as social support, income and job security. Although Siegrist's model only predicts effects of job conditions on CHD, the author has nevertheless shown associations between poor job satisfaction and a variety of outcome measures, including CHD, musculoskeletal symptoms, gastrointestinal symptoms, fatigue and sickness absence (Scott and Taylor, 1985). In bringing together both models, Wall, Jackson, Mullarkey and Parker (1995) suggested that high control jobs are those that give the worker autonomy and discretion, variables which lead to the development and application of increased knowledge and skill. Such knowledge translates into enhanced performance, although well-being is also reinforced through an improved sense of competence, giving support to the notion of a happy-productive worker (Wright and Staw, 1999). However, more recent research has found independent effects of components from each of the models on CHD (Bosma, Peter, Siegrist and Marmot, 1998).

A final work-related variable of interest is the threat of unemployment. A wealth of research has shown both unemployment and the threat of unemployment to have an adverse impact on an individual's well-being, both physically and psychologically (Warr, 1983). Most disturbing are the findings of Pavalco, Elder and Clipp (1993) who found being unstably employed to be associated with a higher risk of death. Moreover Burchell (1994) found that men in insecure employment suffered approximately the same level of poor psychological health as those who were unemployed. Such findings suggest therefore that a worker on a temporary contract, bringing with it a sense of low job security, may suffer more as a result of shiftwork than those employed on permanent contracts.

Recent research has shown personality to be influential in the experience of job strain over time. Indeed, Spector and O'Connell (1994) concluded all job stressors and job strains were predicted by at least one personality variable. The most important attributes in this respect were negative affectivity, an external LOC and Type-A personality, all of which were associated with less satisfaction and more strain. Moreover, Judge (1993) found affective disposition to moderate the relationship between job satisfaction and employee turnover, such that employees with a positive disposition who were more dissatisfied with their jobs were much more likely to quit, whilst Kasl (1973) concluded that job-related tension was greater in introverts compared to extroverts. More recently, Elovainio, Kivimäki, and Kalliomäki-Levanto (2000) reported job satisfaction to depend on the levels of hostility and trait anxiety of individuals, which in turn affected the levels of control felt and the overall satisfaction with the job. Meanwhile Arvey, Bouchard, Segal and Abraham (1989) and Staw, Bell, and Clausen (1986) have suggested that job satisfaction may derive from genetic or early childhood influences.

3.4. Discussion

3.4.1. Multi-Trait Studies

More recent studies in this area are beginning to evaluate individual difference measures in relation to each other rather than as isolated factors (Bohle *et al.*, 1989, 1990, 1993; Kaliterna *et al.*, 1993), positing that it is the interaction between factors that may hold the key to their value as predictors of shiftwork tolerance. Indeed, many of the studies mentioned thus far have found such an interaction. This view was supported by Iskra-Golec, Marek and Noworol (1995) in a study examining the different combinations of individual difference factors and their relationship to shiftwork tolerance by means of indices of disturbed sleep and impaired health. Findings showed individual differences to be differentially correlated with outcomes, depending on whether the factors were examined independently or concurrently. For example, neuroticism on its own did not correlate with chronic fatigue but did so when combined with languidity and morningness. Likewise, when analysed separately, flexibility only correlated with 2 of the 8 outcome measures but increased to 3 when combined with extraversion.

Multiple regression and correlation analyses indicate that some individual difference factors tend to strengthen one another, whereas others have the opposite effect of counteraction. For example, although neuroticism has been found to be the strongest predictor of complaints (Åkerstedt, 1980; Bohle, 1990; Kaliterna *et al.*, 1993), Iskra-Golec *et al.* found this to be the case, but only in interaction with others. Neuroticism and languidity were found to strengthen one another positively in their relation to cardiovascular and digestive symptoms, somatic anxiety and chronic fatigue, whilst flexibility and extraversion amplified one another negatively in relation to chronic fatigue, psychological health, digestive symptoms and night sleep disturbances. Morningness did not alter these relationships. Overall they were able to conclude that the neurotic shiftworker may suffer less from health and sleep problems when they were also categorised as being flexible and extroverted, bringing together many of the findings reviewed above.

3.4.2. *Criticisms*

3.4.2.1. *Scepticism*

Individual differences have been one of the most enduring topics throughout the history of psychological research, with the likes of Freud and Jung establishing early on the scepticism and controversy that has become synonymous with this area, and continues to be an issue today in relation to more contemporary topics. In a review of the relationship between shiftwork tolerance and personality, Härmä (1993) concluded, "the predictive power of...individual difference factors are rather small. It thus seems unjustified to make any definitive selection of the future 'good' and 'bad' shiftworkers before they have had experience with shiftwork" (pp. 107). Monk and Folkard (1985) advocated that it appears "unlikely that we will ever reach a position where we can distinguish between people who are suited and those who are not suited to shiftwork in general" (pp. 237). More recent research has failed to offer an alternative opinion, with Nachreiner (1998) concluding that "there is not much new information on individual differences as determinants of shiftwork (in)tolerance...none of the parameters has any predictive value and this finding has received support elsewhere" (pp. 37). However, he does point out that a comprehensive review of the literature in this area is made difficult by the fact that "the (theoretically possible) number of measures to be covered is probably limited by ones own imagination" (pp. 35).

3.4.2.2. Cause and Effect

A major issue underlying this scepticism is the conceptual problem of establishing cause and effect. In other words, whether shiftwork causes personality changes or whether it is an underlying personality trait that leads to poor adjustment to shiftwork. The only possible solution is to conduct longitudinal studies that test workers before they begin shiftwork and at intervals once they have started working shifts to track those changes in health, domestic, family and social problems that may be attributable to certain individual characteristics. Such work was pioneered by Meers *et al.* (1978) who obtained subjective health scores from workers about to start shifts in a newly set-up Belgian wire mill, conducting follow-up analysis after 6 months and again at 4 years 4 months. Importantly the team were able to test both those who had remained at the plant and those that had left, enabling them to make a comparison of the evolution of subjective health in both groups. They found that increased shiftwork exposure led to an increase in the number of functional somatic complaints (taken as an indication of neuroticism), and that the neuroticism score of those who were later to leave shiftwork was significantly higher than that the group who remained at the plant after 4 years. From this it was suggested that neurotic individuals would make 'bad' shiftworkers. However, whether this lower tolerance to shiftwork caused an increase in neuroticism or whether having a neurotic personality led to a lower tolerance to shiftwork is open to debate, since research has shown an increase in neuroticism following shiftwork experience but not before, suggesting that shiftwork causes neuroticism.

3.4.2.3. Healthy Shiftworker Effect

A major methodological concern affecting the predictive power of certain personality factors in shiftwork adjustment is that of the 'healthy-worker effect', referring to the so-called 'survivor population' (Taylor, 1973) who remain working shifts, as opposed to those who have either been prevented from entering shiftwork or the proportion of existing shiftworkers who either resign, or are forced to change their job for various reasons (Fox and Collier, 1976; Knutsson and Åkerstedt, 1992).

Shiftwork's potential for introducing this effect has been illustrated in studies such as Meers *et al.* (1978), where a number of participants who had originally been enrolled prior to the commencement of shiftwork had left the plant by the follow-up points. Whilst it is often difficult to trace or keep in contact with those who have left in the intervening time, where possible it is essential to include them in further analyses. Such groups are worthy of special attention since they demonstrate low adaptability to abnormal work hours and, therefore, constitute the groups who would appear to be at particular risk. According to Meers (1977) many of the problems commonly associated with working shifts arise soon after individuals take up this type of work pattern, whilst Harrington (1978) suggested that 20%-30% of workers leave shiftwork within 2-3 years due to health problems. Indeed, Koller *et al.* (1978) have shown that a relatively high proportion of 'drop outs' from shiftwork report subjectively perceived health problems. Omitting them from further analyses may lead to an underestimation of the potential harmful effects of shiftwork.

3.4.3. Implications

The points raised throughout this chapter have highlighted certain individual characteristics that have been researched within the shiftwork literature in an attempt to classify those individuals who may be at added risk of working shifts. There are, of course, others that have not been mentioned (e.g. optimism, pessimism, cynical hostility, Type A behaviour). The underlying rationale behind such research is the ability to apply these findings in the workplace in both the selection of potential shiftworkers and the counselling of those currently involved in shiftwork. However, as the discussion has illustrated, this area is accompanied by mixed findings and much debate and so any conclusions drawn must be done so tentatively. Whilst Table 3.1 lists those attributes of the so-called 'good' and 'bad' shiftworker, they should be treated with great caution and only employed as guidelines, if employed at all.

Table 3.1. Attributes of the hypothetically 'good' and 'bad' shiftworker

Good	Bad
Evening type	Morning type
Low circadian amplitude	High circadian amplitude
Flexible sleeping habits	Rigid sleeping habits
Vigouress in overcoming drowsiness	Languid in overcoming drowsiness
Extraverted	Introverted
Stable	Neurotic
Under 50 years of age	Over 50 years of age
Male	Female (esp. with children)
Internal LOC	External LOC

A case in point is the personality attribute of extraversion. Much of the literature advocates extraverted people to be better able to adapt to the changing routines and dysrhythmic schedules typical of shiftwork. Research has also shown them to react in ways that may give rise to other problems such as poor dietary habits and high levels of caffeine, alcohol and nicotine intake. When combined with the fact that people can vary along each of these measures, and, as we have seen, the effect of each of the variables can alter depending on whether they strengthen or counteract each other, research still has a long way to go before the use of individual differences in the selection of personnel becomes any more than a utopia.

Such a list also fails to take account of the type of shift system worked since one would predict that those with a tendency toward eveningness would be better able to tolerate late or night shifts whilst M-types would be better adapted to early or day shifts. Until more methodologically sound research is carried out, using a longitudinal approach and psychometrically sound measures, the variables listed above should be taken as nothing more than an oversimplified summation of the findings to date, with the intention of provoking thought for future research in the field.

Despite such negativity, the study of individual difference measures in relation to the serious real-world problem of shiftwork tolerance deserves attention, since the results of a large number of studies have established a link between demographic, chronobiological and work-related factors and workers reactions to shiftwork. Interest in such research stems from the implication that workers can be vetted, and their suitability for different types of work patterns assessed, before they embark upon shiftwork. Differences between individuals are rarely taken into account when selecting individuals for employment. Indeed, in the large majority of cases age, experience, and availability are taken as better indicators of a person's eligibility to work. All too often, little or no regard is given to work history or problems encountered as a result of prior shiftwork experiences. Having a set of criteria on which to assess the suitability of shiftwork tolerant people should reduce both the health risks to them and the costs of sickness, absence and compensation for the company. Such information could also benefit those who are already involved in shiftwork by counselling workers on ways to manage and cope effectively with problems arising from their shiftwork schedule.

Thus in this sense, it is of no use simply documenting differences in shiftwork adjustment between one individual and the next. Rather the need is for large-scale longitudinal studies designed to test individuals within and between shift patterns, and before and after embarking upon shiftwork. Only then can the reliability and stability of the dimensions upon which people differ, and by which people can be classified and compared, be identified. In the light of such applications, the study of individual differences in relation to shiftwork tolerance is extremely important and goes beyond purely academic interest.

4

PATHWAYS FROM SHIFTWORK TO OUTCOMES

4.1. Introduction

The accumulated evidence to date suggests a causal relationship between shiftwork and impairment of health and well-being, and the recognition that such relationships can be mediated by other variables (e.g. individual differences). Despite this researchers have failed to agree on the specific pathways by which these relationships develop. In an attempt to define the pathway from shiftwork to the array of associated outcomes, a number of models have been proposed that recognise and introduce the role of modifier variables and how these interact with life domains to determine how well a person tolerates working shifts. In order to bring together the information from the previous two chapters, the following discussion reviews these models. Within it one can begin to observe a transition from the more traditional, simple linear progression which asserts that the work pattern or circadian disruption is the fundamental key to outcomes, towards a more modern, complex and in-depth view, incorporating dynamic relationships and multidirectional pathways, involving not only individual factors but also situational and environmental variables. Such an evolution is perhaps not surprising given the constant introduction of new variables that comes from the wealth of research into the impact of shiftwork on all aspects of workers lives.

4.2. Models of Shiftwork Tolerance

4.2.1. The Circadian Disruption Model

Rutenfranz (1976) produced one of the first models of this type and argued that the relationship between shiftwork and health could be explained by three components: objective stress, subjective strain and intervening variables (see Figure 4.1). According to the author the major disease mechanism in shiftworkers was objective stress caused by the desynchronisation of circadian rhythms due to the conflict between working and sleeping hours. Such stress, he proposed, was responsible for subjective strain manifested by lowered well-being, changes in eating habits and disturbed sleep and family life. However, the pathways between stress and subsequent strain could be mediated by several intervening variables, including housing standards, sleeping conditions, family situation, personality and psychological adaptability. Thus, according to Rutenfranz "These intervening factors determine if a particular person is able to cope with shift work, or if the disturbance of well-being will be augmented to such a degree that acute diseases will occur" (pp. 166). The idea that desynchronisation of circadian rhythms is the major mechanism of the adverse health effects of shiftworkers has been supported by the likes of Reinberg *et al.* (1984) who reported that shiftworkers who had medical and social problems tended to show internal desynchronisation between their body temperature rhythm and their sleep-wake cycle, whilst those workers who were better able to tolerate shiftwork showed no evidence of circadian disruption. However, in contrast Knutsson and Åkerstedt (1990) argued that the social environment can act as a modifier in the relationship between disturbed circadian rhythms and ill health, but can also act as an independent pathway, as suggested in later models.

Figure 4.1. Model of relations between stress, intervening variables and strain in connection with shiftwork (Rutenfranz, 1976; cited in Rutenfranz *et al.*, 1981)

4.2.2. The Psychosocial Model

In the same vein, Åkerstedt and Fröberg (1976) proposed a simple model of psychosocial factors and disease/disability (see Figure 4.2), using disruption of the circadian system as the hub of the pathway between shiftwork and ill health. Indeed, their belief in this principle led them to state that "all attempts to carry out research on shiftwork problems should, directly or indirectly, centre on circadian rhythms" (pp. 184).

In its general form the model argues that environmental stimuli, (e.g., work hours), interact with the individuals psychobiological program (their circadian rhythms) to cause the disturbed rhythms typical of shiftworkers. In addition pre-shiftwork socio-temporal patterns, together with the patterns of family and society, cause the initial problems of shiftwork. It is well established that shiftworkers suffer from a host of social handicaps which, according to the model, are the result of the post socio-temporal patterns of the shiftworker conflicting with that of the family and society, in turn producing various degrees of social inadequacy. The consequence of this conflict, in the form of stress reactions, may, under certain circumstances lead to physiological costs and in the long-term to either the precursors of, or actual, disease and disability.

Furthermore, Åkerstedt *et al.* add that the sequence of events should be viewed, not as a one-way process, but as a 'cybernetic system' with continuous feedback.

Figure 4.2. A theoretical model for psychosocially mediated disease (from Åkerstedt *et al.*, 1976, pp. 181)

4.2.3. The Destabilisation Model

In contrast the later model by Haider, Cervinka, Koller, and Kundi (1988) moved away from the circadian approach and instead put strong emphasis on psychosocial factors (see Figure 4.3). Based on a comprehensive cross sectional analysis of different age groups of shiftworkers, dayworkers, and drop-outs, they proposed a complex interaction between the shiftworkers cognitions, behaviour and the dynamic interrelationships between shift related problems. According to this model, the balance between the three domains of sleep, social/family life and attitudes towards shiftwork are essential in regulating circadian homeostasis. In the words of Haider *et al.* "health is preserved as long as the working sphere remains in a stabilised, dynamic equilibrium. As soon as partial impairments due to long term shift work are no longer regulated, balanced or compensated, the destabilised equilibrium leads directly and indirectly to increased health risk" (pp. 209). The model asserts that the work/non-work conflict caused by shiftwork destabilises the 'dynamic equilibrium' between the three domains and it is this that leads to impaired adaptation and well being.

According to this model there are two pathways from shiftwork to health. In the first, the functioning of the various domains has a direct effect. This is certainly supported by findings, as discussed in the previous chapter, indicating possible health effects of impaired social (Bohle, 1990; Knutsson, 1990) and family life (Bohle *et al.*, 1989, 1993; O'Driscoll, 1996; Taylor *et al.*, 1997). In the second pathway the development of risk behaviours, such as poor eating habits or an increase in smoking or caffeine intake, in response to destabilisation are purported. Coping and adaptation, according to this model, are defined as the ability to balance the conflict between the three major domains.

Figure 4.3. Model of the complex interaction structure of shiftwork effects
(from Haider *et al.*, 1988, pp.211)

As with the previous model, Haider *et al.* argued that the impact of such destabilisation would be mediated by certain intervening variables, including work characteristics, social environment, personality, shiftwork experience and age. Thus since inexperienced shiftworkers will have to go through a period of adaptation characterised by destabilisation in the three domains, shiftwork would be expected to have a significant impact on health. In contrast the experienced shiftworker should suffer less because the impact of the work schedule upon their family and social lives would have adapted and stabilised. However, experienced shiftworkers may not be at an advantage since they may have increased their risk behaviours in order to cope better with their situation. Also the risk of certain disorders such as CHD are known to increase with age, irrespective of shiftwork experience.

4.2.4. The Triad Model

The idea of coping introduced by Haider *et al.* was used as a basis for the triad model proposed by Monk (1988), shown in Figure 4.4. In the same way that Haider *et al.* explained adaptation to shiftwork on the basis of three main domains, Monk argued that the ability to cope with shiftwork was determined by a triad of interrelated factors. The first component, desynchronisation of circadian rhythms, means that those factors controlled by rhythmic components (e.g., the sleep-wake cycle or gastric function) will suffer as a consequence. Sleep, the second component, is influenced endogenously by the body clock and exogenously by such factors as ambient noise and light during the daytime, or the interruption of sleep in order to join in with the family meal. This leads onto the third and final domain, social and domestic interactions, since both the quality and quantity of such activities can be affected by the level of circadian disruption imposed by the shift schedule. This in turn can affect the amount and placement of sleep needed. Thus according to Monk the relationship between the three factors is such that the interruption of one can affect the remaining two components, leading to problems adapting to shiftwork and to impaired health and well-being.

Figure 4.4. Triad of shiftwork coping factors (Monk, 1988, pp. 196)

4.2.5. *Stress and Coping Model*

In a more complex approach taken by Olsson, Kandolin and Kauppinen-Toropainen (1990) the influence of the individual and their coping strategies on health outcomes were discussed (see Figure 4.5). According to this model the shiftworkers' environment presents him with a number of potential demands or stressors, including both occupational (e.g., shiftwork, lack of autonomy, time pressures and monotony) and non-occupational factors (e.g., life strains). Using the principles of the model of stress proposed by Lazarus and Folkman (1984), Olsson *et al.* posited that the shiftworker attempts to cope by evaluating the amount and type of stress in their environment through a process of cognitive appraisal, with appraisal being influenced by the workers' attitudes, self esteem and previous experiences. Coping strategies used can be either active (problem-focused) or passive (emotion-focused). In the former the worker takes action to deal with the problem, and may involve them changing their sleeping routines to allow greater interaction with friends and family. In the latter the worker may not deal with problems directly, but instead regulate their emotions regarding their difficulties (by talking to their supervisor or colleagues, for instance). In contrast to the earlier models, where coping was purported to be influenced by the functioning of a triad of domains, coping in the present model is depicted as being the cognitive and behavioural efforts the individual brings to the situation in order to manage their problems.

Figure 4.5. Model of shiftworker's coping with stress (from Olsson *et al.*, 1990, p. 177)

As was the case with Haider *et al.*, Olsson *et al.* proposed two possible pathways from shiftwork to impaired health and well-being, or in their terms 'stress reactions'. In the first direct route, they argue that occupational stressors can directly affect the stress reactions of workers, resulting in impaired mental well-being, satisfaction, sense of purpose in life, time away from work and symptoms. In the second 'indirect route', the choice of coping strategy used will moderate the stress reaction, in turn affecting the coping resources available to deal with further problems. Thus, unlike the models discussed this far, Olsson *et al.* proposed that organisational and non-organisational stressors can directly influence the health and well-being of the shiftworker, and, in addition to personal factors such as gender, education, and self esteem, previous experiences and age will affect how the individual appraises the situation. The nature of the environmental stressors and the individuals' appraisal will determine the type of coping strategy used in defence, which in itself will determine the availability of resources for further coping. Thus in this sense, the model implies that the shiftworker with many physical and psychological symptoms will have fewer resources to cope than a shiftworker who has shown few.

4.2.6. The Behavioural Model

Incorporating aspects from each of the models above, Knutsson and Åkerstedt (1990) modified previous models by introducing behavioural changes (see Figure 4.6), first introduced by Haider *et al.* (1988), in the form of risk factors, as an independent pathway from shiftwork to disease. They proposed that shiftwork causes a mismatch of circadian rhythms leading to increased susceptibility to disease, sleep/wake disturbances and internal desynchronisation, all of which can result in actual disease. On the other hand shiftwork can also cause disturbances to socio-temporal patterns impairing social interaction, causing stress, and forms a second pathway to disease. However, Knutsson *et al.* argue that whilst there are interactions between changes in behaviour, social rhythms, and sleep/wake disturbances they are complex, and it is important to recognise that behavioural changes in shiftworkers cannot exclusively be explained by disturbed circadian rhythms alone. The authors therefore emphasise that it may be the behavioural changes brought about by shiftwork that constitute an independent pathway from shiftwork to disease, rather than simply shiftwork itself.

In support of the model they discuss the research to date showing a relationship between shiftwork and CHD. As they note, CHD is a condition with many risk factors, of which hypercholesterolaemia, hypertension and smoking are the most notorious. Knutsson *et al.* posit that disturbances in sleep and social routines imposed by shiftwork may result in an increase in these risk factors and increase susceptibility to disease. However, they also suggest that, from evidence showing an increased prevalence of risk factors in shiftworkers, factors unrelated to circadian rhythmicity (perhaps environmental variables such as the prevalence of smoking in the workplace, the monotony of the work or the number and opportunities for scheduled breaks) may have a role to play. In other words, they suggest that over and above circadian disruption, shiftworkers may be predisposed to the risk factors for CHD.

Figure 4.6. A model of disease mechanism in shift workers (from Knutsson *et al.* 1990)

4.2.7. The Five-Factor Effects Model of Viability

In an original approach Brown (1990) suggested that altered illumination regimens could negatively affect the functioning of various organisms, after research showed that altered illumination schedules resulted in the sudden deaths of experimental animals (Brown, 1981; 1982, cited in Brown, 1990). In assessing these deaths, Brown concluded that they appeared to be the combination of two major groups of stressors. These were the "inverse or rapid rotation lighting schedules with simultaneous exposure to changing immediate stimuli, the latter alone which apparently did little harm" (pp. 356). When applied to diurnal animals, such as humans, Brown argued that they will first attempt to alter their activity to conform with the new lighting regimen. Physiologic changes then follow. However, the shiftworker can still be under the influence of the natural ambient illumination as well. For instance, the nightworker is exposed to artificial illumination in the workplace during their shift which will influence the circadian system towards its daytime active state. When the nightworker attempts to sleep following the shift they are exposed to natural daylight which again activates the circadian system, adversely affecting both the quality and quantity of sleep. Such constant illumination, according to Brown, will prompt a change in physiologic rhythms to compensate for the continued activity. In the case of disturbed sleep, this may result in impaired alertness and napping. In this way the shiftworker can be seen to be affected in both their sleep and wake time.

As with the other models, Brown proposed several intervening variables capable of mediating the extent to which the natural and artificial illumination regimens will affect the worker. The first is basic physiology, including age, gender, diet, state of health and ease of biological rhythm adaptability. As we saw in the previous chapter, certain circadian characteristics such as the phase (M- versus E-type), amplitude, or type (flexible versus rigid sleepers), in addition to age and gender have all been linked to a person's ability to tolerate shiftwork.

Figure 4.7. Five-factor effects model of viability for shiftwork (adapted from Brown, 1990, pp. 360)

The second set of intervening variables comprise family and social relationships and include both role demands and level of social support. Finally, there is the "personal equation" of the shiftworker himself, which includes the worker's desires, motives, goals, commitments, reasons and justifications for continuing shiftwork. Together with the natural and artificial illumination these intervening variables constitute the 5 factor model of viability (health), as shown in Figure 4.7. Whilst this model appears to include many of the variables that have been discussed with regard to shiftwork tolerance, a major weakness is that it does not discuss the ways in which they affect health, simply that they do. Brown simply states that they are "independent variables which interact in a complex network" (pp. 359).

4.2.8. The 'Employee-Centred' Model

In a similar vein to Knutsson *et al.* (1990), Bunnage (1984), using an 'employee centred' approach, proposed that shiftwork, by its very nature, involves time patterns (both in terms of work and non-work activities) that differ from those characteristically seen in the community. In this way, shiftwork can lead to disturbances in both biological rhythms (e.g. sleep, wakefulness, appetite and digestion) and those of the family and society, which together, can result in a number of consequent complaints, including poor physical and mental health, as well as disruption to family/social life and work life (see Figure 4.8).

Figure 4.8. A framework for the study of various consequences of shiftwork for the workers (from Bunnage, 1984)

Furthermore, consequent variables are inter-related, in that shiftworkers who experience problems in their social and family life to a greater degree than other workers, also experience problems with their physical and psychological health, suggesting a causal chain of events. Such outcomes can influence a workers subjective experiences and attitudes towards shiftwork.

As with other models, adaptation of rhythms can be mediated by a number of modifying variables, including individual, situational, family and work sector characteristics.

Thus, central to the framework is the idea that shiftwork causes disruption to a worker's routines and time patterns that adversely affect both their internal and external rhythms. Implicit is the assumption that if these rhythms do not adapt, the worker will suffer disturbances to a number of key life domains, both in and out of work.

4.2.9. The Conceptual Model

One of the most contemporary models of the manner in which shiftwork can affect the health of an individual is provided by Folkard (1993) who, combining all of the features included in one or more of the models above, posits a simple conceptual model (see Figure 4.9). Unlike the rather complicated and elaborate explanations and inter-relationships suggested by previous authors, Folkard combines elements resulting from the extensive body of shiftwork research as a way of not simply showing trends, but also highlighting those areas where the links are more tenuous and require further research for clarification.

The model brings together the complexity and multi-faceted nature of shiftwork research. Thus for example, one line of research concentrates on the manner in which features of shift systems (e.g. timing, duration, rotation) themselves can influence health and safety. In one branch a direct impact is hypothesised, whilst in another a more indirect path is suggested whereby the inter-related disruptions of endogenous rhythms (e.g., the circadian clock, sleep and family and social life) can be modified by the characteristics of an individual and situational circumstances (e.g., marital status or commuting time to work), all of which can determine the magnitude of effects on both acute and chronic health and well-being. According to the model, physical health and safety stem primarily from the chronic effects on mental health, whilst safety can also depend on affect and cognitive performance (although Folkard emphasises the paucity of research examining the impact of physical and mental health on shiftwork safety).

4.2.10. The Statistical Model

The most recent model was proposed by Smith, Robie, Barton, Smith, Spelten, Totterdell, Folkard, Macdonald and Costa (1999). Here the authors took a different approach from models before them and empirically tested and validated a number of specific hypotheses (see Figure 4.10). The model was based on a 'mid-range approach' (Taylor *et al.*, 1997), which attempted to refine earlier models by concentrating on specific individual and situational variables rather than advocating that all such variables would have similar effects.

Figure 4.9. A conceptual model of the manner in which the various problems associated with shiftwork relate both to one another, and to the features of the shift system (from Folkard, 1993, pp. 2)

In an extension of the stressor-strain framework suggested by Olsson and colleagues, Smith *et al.* proposed that personality, age and workload negatively influence sleep, family and social life. Disturbances in these areas provoke coping efforts as the shiftworker attempts to manage and control these disruptions and the stress they produce, with the extent of the problems being dependent upon the usefulness of the strategies employed. For example, effective coping strategies are those that alleviate the problem, terminating the process. Ineffective coping strategies may lead to short-term effects (e.g. emotional problems, job dissatisfaction, fatigue and anxiety), which if continued, may eventually lead to more chronic health impairments (e.g. gastrointestinal and cardiovascular symptoms).

Figure 4.10. Path analysis to show the temporal relationship of the major outcome and moderator variables (from Barton *et al.*, 1995)

In order to determine its generalisability within and across occupational groups the model was tested on two large samples of nurses and midwives, one of which worked permanent night shifts and the other on various types of rotating shifts. This was then cross-validated against a sample of male industrial workers.

The adequacy of the fit of the model and its components was assessed using structural equation modelling (path analysis). Whilst noting some sample specific effects, results showed an acceptable fit of the data in each of the 3 samples, leading the authors to state that "the progressions of events leading to unsuccessful adaptation is clear" (pp. 215), providing support for the generalisability of the model across both organisations and occupational groups. As predicted, regardless of shift type or industry, workers with decreased flexibility and perceived workload showed greater sleep disturbances. Such disturbances triggered an increased use of disengagement strategies leading to short-term outcomes such psychological health problems and fatigue, which in turn were found to be associated with the development of digestive and cardiovascular complaints. Despite the authors' recognition of the limitations of their work, both demographically (they were unable to test the possible confounding effects of gender since the nursing populations were overwhelmingly female, and the industrial workers were almost totally male), and statistically (e.g. statistical constraints prevented them from investigating possible interactive effects), Smith and colleagues concluded that "As a confirmatory effort toward building a theoretical base for future shiftwork theory, research, and application, this study demonstrated the variety and complexity of the constructs and processes involved in such an adaptation" (pp. 217). It is this complexity that the present thesis aims to explore further.

4.3. Discussion

4.3.1. A Comparison of Models

A common feature in all models is in their recognition that (1) shiftwork is associated with disturbances to both biological and societal rhythms that give rise to impairments to health and well-being, and (2) that the strength of these pathways can be mediated to a greater or lesser extent by other variables. However, each model takes a different approach in modelling the manner in which these elements interact, placing a different emphasis (and indeed, in some cases, no emphasis) on the relative impact of the work pattern, coping strategies and circadian disturbances.

4.3.1.1. Work Pattern

The primary importance of the work pattern in the relationship between shiftwork and ill health was advocated in the models by Åkerstedt *et al.* (1976), Knutsson (1989) and Rutenfranz (1976). Although each recognises the mediating impact of other variables, such as personality, all three models portray a linear relationship between shiftwork and health. Thus, in these models there is a direct relationship between shiftwork and problems. Later models began to argue that shiftwork problems have a complex aetiology that cannot be explained in simple linear terms, with the likes of Haider *et al.* (1981), Monk (1988b), Olsson *et al.* (1990) and Smith *et al.* (1999) purporting that problems are the result of the multi-directional interactions between the work pattern, life domains (e.g. social, family, sleep etc.), circadian rhythm disruption and health. Thus later models portray shiftwork as one of a number of possible interacting factors that can lead to difficulties.

4.3.1.2. Characteristics of the Shiftworker

The role of the shiftworker him/herself also varies between models. For example, Åkerstedt *et al.* (1976), Bunnage (1984), and Rutenfranz *et al.* (1976) all fail to describe the impact of coping strategies, whilst Monk (1988b) visualises the ability of the worker to cope with a triad of domains as a key predictor of successful adaptation to shiftwork. One of the first to address the relative impact of the shiftworker's behaviour were Haider *et al.* (1981) who defined coping in terms of maladaptive 'risk behaviours' (e.g., poor eating habits or an increase in smoking or caffeine intake), in response to destabilisation. Risk behaviours are also emphasised in Knutsson's (1989) behavioural model, where attempts to cope with disturbed social rhythms are again seen in terms of 'increased smoking' and poor dietary habits, which lead directly to disease. Such behavioural changes are viewed as acting independently of circadian rhythms and the notion of possible feedback to other elements within the model are totally ignored. In contrast Olsson *et al.* (1990) emphasise the importance of such feedback in their model by proposing that, dependent on the choice of coping strategy adopted by the worker, the outcomes of shiftwork may be moderated. The success of such coping can then in turn affect the coping resources available to deal with further problems.

Apart from coping strategies, a further characteristic of the shiftworker seen to have an impact on tolerance is attitudes and commitment to shiftwork. Brown's five-factor model of viability incorporates the "personal equation" of the shiftworker himself, which includes the worker's desires, motives, goals, commitments, and reasons and justifications for continuing shiftwork. Whilst Brown implies that the personal equation can lead directly to illness, Haider *et al.* portray it as a factor that affects ill health through the interaction with risk behaviours. In contrast, Bunnage posits it as a consequence of disturbances to shiftwork related outcomes.

4.3.1.3. Circadian Disruption

The relative power of circadian rhythms is also debated throughout the models with some authors portraying the desynchronisation of circadian rhythms as the major mechanism of adverse health effects (Åkerstedt *et al.*, 1976; Rutenfranz *et al.*, 1981) whilst others acknowledge the equal role of social and circadian rhythms (Bunnage, 1984; Knutsson, 1989, Monk 1988b). Perhaps the most extreme opinion is that taken by Åkerstedt *et al.* (1976) who state that "all attempts to carry out research on shiftwork problems should, directly or indirectly, centre on circadian rhythms" (pp. 184). Such a stance is evident in the models of both Rutenfranz (1976), where the major disease mechanism in shiftworkers was purported as the objective stress caused by the desynchronisation of circadian rhythms due to the conflict between working and sleeping hours, and Åkerstedt and colleagues (1976) where the interaction between environmental stimuli and the individuals 'psychobiological programs' were thought to cause the disturbed rhythms typical of shiftwork.

4.3.1.4. The Inter-Relationship of Problems

That the shiftworker's problems are inter-related is a common theme, although a review of the area reveals a development from the simplistic approach of Bunnage to the more detailed explanation of Haider *et al.* and Monk. For example, Bunnage states that shiftworkers who have problems in one area will have problems in other areas. However, these are limited to social/family life, psychological health and work. Haider *et al.*, on the other hand proposed that problems are created when conflicts exist between interrelated areas of family life, sleeping and attitudes. Thus in this view, problems are created when the shiftworker invests in one area of life at the expense of another. In a similar vein Monk (1988b) hypothesised that sleep, biological clock and social/domestic factors were so inter-dependent that "a failure in one ...can negate any advances made in the other two" (pp. 169).

4.3.1.5. Theoretical versus Statistical

Until Smith *et al.* (1999) there had been no direct, systematic empirical tests of shiftwork models (Taylor, Briner and Folkard, 1997). Although the models of Haider *et al* and Knutsson *et al.* were based on results of experimental research in the applied setting the relationships they hypothesise generally go beyond the results found. For example, Haider *et al.* state that the model they propose is mainly hypothetical but emphasise that it is nevertheless based on their own empirical findings in addition to other experimental and non-experimental data and on "known facts". Knutsson *et al.* performed both cross-sectional prospective and longitudinal research, investigating the relationship between shiftwork and CHD. Whilst the data provided evidence of a dose response relationship between years of shiftwork and heart disease, the authors went beyond this data to infer a model of the aetiology of *all* diseases affecting shiftworkers. Furthermore, despite the fact that measures of circadian and social disturbances were not included in the research, they nevertheless proposed that both could cause disease.

Thus, up to this point models had served as heuristic frameworks based on the large body of literature and had been largely developed to generate future research. Despite the obvious argument that causality was inferred through statistical analysis rather than repeated measures, the fact that Smith and colleagues provides one of the strongest confirmatory tests to date of the processes underlying the relationship between adaptation to shiftwork, and impairments to health and well-being, is perhaps an indication of a renewed interest in attempting to gain a more in depth perspective of how and why shiftworkers are affected by their work pattern.

4.3.2. Conclusion

Whilst building models to explain the association between shiftwork and health may be theoretically valuable, understanding the causality and magnitude of the association between the two is lacking. Therefore, the extent to which they can be used for more practical purposes, in the design of schedules or the education of shiftworkers for instance, is far less convincing. According to Taylor *et al.* (1997) "Current shiftwork models are so broad and unclear…that a practitioner would have extreme difficulty in deriving from them a specific, detailed intervention outline" (p. 79). Thus, in this sense the sentiments uttered by Åkerstedt and Fröberg (1976) that "The model was developed to visualise the areas which seem important to us and particularly to point out which possible connections should be studied. This means, of course, that the model is highly speculative" (pp. 184) when the first models were beginning to be generated, could also be true of the situation today.

Little progress has been made in finding the causal pathways between shiftwork and ill health since this time, although the most recent models have attempted to validate their hypotheses. The multifaceted nature of many of the disorders commonly seen in shiftworkers makes it extremely difficult to pinpoint those that cause most risk and in what circumstances these risks are heightened. In order to answer these questions, research needs to become more well controlled, using systematic and standardised methodology, taking account of those workers who have left shiftwork as well as those who remain. Only then may we be able to compare research findings, using the generalisations in the applied rather than the theoretical setting.

Models map the potential relationships among different areas of research within the shiftwork domain. They are heuristic aids rather than accurate descriptions of the data, are predominantly hypothetical and conceptually broad, and are becoming increasingly so by encompassing more variables and a greater number of interrelationships among them. Existing models need to be investigated to establish their validity and improve their clarity, using narrower theories specific to shiftwork findings developed directly from empirical studies. Herein lies the aim of the present thesis.

5

PART 1: A PHENOMENOLOGICAL APPROACH TO UNDERSTANDING SHIFTWORKERS' PROBLEMS

5.1. Introduction

The present chapter forms the first part of an empirical assessment of the way in which shiftworkers experience shiftwork; how they perceive shiftwork problems, how they experience them, how they cope with them and how they visualise the interaction between not only problem domains but between the outcomes and modifiers identified throughout the review chapters. Thus the overall aim was to understand the nature of shiftwork through the eyes of shiftworkers themselves. Using a phenomenological approach this was achieved through semi-structured interviews with the emphasis on obtaining qualitative rather than quantitative data. According to several authors (e.g. Smith, 1995, 1996), information obtained from a phenomenological perspective can be useful in challenging structural and normative assumptions, such as those encompassed by the models of shiftwork tolerance discussed in the previous chapter. It was felt that taking an holistic, bottom-up approach would not only aid the development of working hypotheses, grounded in the context of the shiftworker's experiences rather than based on theory, but would also help to gain a more informed understanding of the relative scale of the problems encountered. This information was then used in guiding the selection of scales to be employed in the survey to follow. Taken together the information gained here would be important in ensuring that the questions posed within the questionnaire were phrased in the correct manner and that the most important areas were given more attention. Thus, rather than simply quantifying the outcomes of shiftwork, the interview stage of the research attempted to conceptualise them and understand their meaning to the individual. The main aims of the present study were to:

1. investigate the aetiology and management of problems experienced by shiftworkers as a result of their work pattern using a phenomenological approach;
2. get acquainted, and establish a rapport, with those who would be participating in the study in the long term;
3. help the participants feel personally involved and motivated to get involved in the project, and to establish, early on, that the implications of the findings were aimed primarily at the individual, rather than the organisational, level;
4. use the information gained here to guide the selection of scales to be used in the proceeding survey.

As an additional question the company were interested to discover whether there was a need for change in the work patterns adopted at the site. This was also examined from the shiftworker's point of view.

5.1.1. *Interview Technique*

The reliability and validity of qualitative data such as that obtained from interviews has been widely criticised, with common objections being that they are time consuming and expensive to implement, that they elicit non-comparable data, and create difficulties in the analysis and interpretation of data (Wagner, 1949; Ulrich and Trumbo, 1965, Schmitt, 1976; Arvey and Campion, 1982; Harris, 1989). In their defence, the use of interviews as a method of data gathering does have value when used in conjunction with other methods, such as a questionnaire, or when used as a preliminary measure in obtaining information to be used in further research, since it allows the arena to be explored in an open ended manner before attempting to structure the data in some way.

Choosing the technique to be employed in interview situations is crucial, since different techniques are more suitable than others and depend to a large extent on the nature of the information that needs to be elicited. Using interview techniques that are rigid and structured, for example, make diversions difficult, should they be necessary, and can result in the process seeming to be rather starched and formal. Such techniques are best suited to situations where time is limited and where specific information needs to be gained in employment selection situations, where answers to a number of specific questions need to be explored (e.g. relevant work experience and personal qualities). In contrast, when the primary aim is to gain an understanding, and define the nature, of certain problems and their causes, an unstructured approach is generally more relevant. In light of the objectives highlighted above, the present study employed a semi-structured paradigm because it enabled a number of key topics to be covered, whilst at the same time being sufficiently flexible to allow modifications to take place during the interview itself. This allowed the sessions to be tailored to each individual, making it more personal. Furthermore, it also allowed for the identification of variables that may have contributed to the fuller picture, but which may otherwise have been missed, had a more rigid structure been imposed.

An additional advantage of interviewing workers in this way was that they essentially became the draftsmen for the selection of scales to be employed in the subsequent survey. Thus, rather than using the more traditional method of basing the design of the questionnaire on theory, it was hoped that by involving participants at an early stage and taking the impetus directly from them, only the most relevant measures would be included, targeting those areas that proved to be most pertinent to the shiftworkers themselves. The main incentive behind this was the idea that only by taking the initiative from those who actually work shifts and suffer the associated problems, can research such as this become a worthwhile and educative exercise for both shiftworkers and researchers alike.

5.2. Method

5.2.1. Participant Recruitment

Interviews took place within a computer peripherals manufacturing company in the South of England. All employees working within the production area of the site were introduced to the research project by their line managers and supervisors during their regular weekly coffee meetings. All were informed that their participation was completely voluntary and that declining to do so would not be held against them. Those who volunteered to take part were given an appointment by their line supervisors to attend the interview. Interviews took place during work time in conference rooms around the site, with only the interviewer and worker present.

5.2.2. Participants

A total of 90 interviews took place over a course of 3 weeks. All those who participated did so on a voluntary basis and were interviewed individually during work time. Of those interviewed, 60 employees worked a 'swing shift' schedule, an 8 hour discontinuous rotating system involving a week of 'Early's' (06:00-14:00) followed by a week of 'Late's' (14:00-22:00), 23 worked a permanent night shift (22:00-06:00), and 7 were employed on a Flexible Work Option (FWO), whereby working time was individually tailored to suit the individual's own personal preferences and needs. The following sections discuss the demographics of those interviewed according to shift type.

5.2.2.1. Rotating without Nights

43 male and 17 female swing shift workers were interviewed, 42 of which were employed on a permanent, and 18 on a temporary, contract. All worked on a full-time basis. The average length of time working at the site was 5 years 10 months ($\bar{x}$ 69.942 months; SD 44.775) although this ranged from as little as 2 months to as long as 15 years. The average length of time working the swing shift pattern was 4 years 6 months ($\bar{x}$ 53.692 months; SD 36.301) although, again, this varied widely (2 months to 13 years).

5.2.2.2. Permanent Nights

16 male and 7 female nightworkers were interviewed, 20 of which were permanent employees and 3 temporary. All worked on a full-time basis. Mean tenure was 7 years 8 months ($\bar{x}$ 91.696

months; SD 55.371; range 2 months – 15 years). Average length of time working the night shift was 2 years 9 months ($\bar{x}$ 32.804 months; SD 30.821) with a range of 2 weeks – 8 years. The smaller number of employees interviewed on this shift reflected the fact that only one production line was operative at night and thus only a skeleton crew of support staff was required.

5.2.2.3. Flexible Work Option (FWO)

4 male and 3 female employees on the FWO were interviewed, all of whom were employed on a permanent contract. Five of the seven worked on a full-time basis. The shift systems represented in this sample were as follows:

- a discontinuous system of 'early's' (06:00-14:00) (n=2);
- a discontinuous system comprising a week of 05:30-14:30 followed by a week of 13:30-22:00 (n=1);
- on a part-time basis comprising a week of 14:00-22:00 followed by a 3 day week of 08:00-14:00 (n=1);
- on a part time basis of 3 'late' shifts (14:00-22:00) a week from Monday through Wednesday (n=1);
- a discontinuous 8.5h 'day' shift from 07:00-15:30, Monday through Friday (n =1);
- a discontinuous 11.5h 'day' shift from 07:00-18:30, Monday through Saturday (n=1).

Whilst the sample could be categorised into four groups, those working 'permanent early's', 'permanent late's', 'a combination of early's and late's' and those working the equivalent of a 'day shift', the number of participants working in each of the schemes was too small to be treated in separate categories. Chi square analysis of the demographic variables (gender, presence of children, marital status, job title, part time/full time, permanent/temporary) and one way analysis of variance on the length of time working at the plant and working the current shift pattern revealed no significant differences amongst the groups. Likewise, comparison of ratings for the perceived severity of problem areas (discussed in detail in Section 5.3.1) between groups (permanent early's', permanent late's', early's and late's, and days) did not differ significantly ($F(3,19) = .000$, $p>0.05$). Although it may be argued that the similarities could be attributed to the small sample sizes in each of the shift patterns, it was considered reasonable to combine all those on the FWO into one group. Thus mean tenure of this group was 10 years 3 months ($\bar{x}$ 122.857; SD 51.934; range 24 months - 14 years). Length of time working the FWO was 3 years 2 months ($\bar{x}$ 37.786 months; SD 44.719; range 1.5 months – 9 years).

5.2.3. *Materials and Procedure*

On entering the room, participants were debriefed as to the nature of the research and the aims of the interview itself (Appendix 1). In order for them to introduce themselves, they were asked for the name of their production line, their job title, the shift pattern they worked, the length of time they had been working at the site, their marital status and number of dependants. A subjective description of the job they performed was also obtained. To centre the discussion around the theme of shiftwork each individual was asked whether they experienced any problems as a result of their work schedule.

Although the remainder of the interview was essentially led by the participant, in that it was centred around and guided by the information they provided, it was nonetheless semi-structured around 5 key areas commonly identified throughout the literature. These were: (1) Sleep Problems & Fatigue, (2) Social & Recreational Conflicts, (3) Domestic & Family Conflicts, (4) Eating Behaviour & Diet, and (5) Health & Well-Being. If any of these key domains were not mentioned, participants were asked specifically whether they experienced problems in these areas. Where problems were highlighted, the coping strategies used to manage them were also explored. Before the close of the interview, participants were asked whether they had any suggestions for improving the design of their current work pattern, i.e. what they would change about the system if they were given the chance to do so. An Interview Plan (Appendix 2) was used by the interviewer to guide and prompt the discussion. Sessions lasted for between 15 and 45 minutes.

On completion of the interview participants were asked to fill in a Ranking Sheet (Appendix 3) containing the list of key domains. Using a 5 point Likert scale (where 1 represented "extremely problematic" and 5 represented "not problematic at all") they were instructed to rank how severe they perceived each area to be in terms of their personal situation. Spaces for additional problem areas were also provided. At the bottom of the ranking sheet they were asked whether they were happy with their current shift pattern, and if not satisfied, to write down the type of working pattern they would prefer. Those working a rotating pattern (swing shift workers and those working two types of shift as part of the FWO) filled out separate sheets for each shift type.

5.3. Results

Results are divided into 3 sections. **Preliminary Analysis** discusses the main findings from the ranking sheets, whilst **Interview Summaries** elaborates on some of these findings by presenting an in-depth discussion of details that surfaced during the interviews but that were not evident in the ranking data. Each of the five problem areas are covered separately and the links between them are discussed. **Shift Preferences** discusses whether those interviewed would choose to remain working their current shift system or alter it in some way.

5.3.1. Preliminary Analysis

Preliminary analysis of the data from the ranking sheets showed that the extent of problems experienced varied as a function of the shift type itself. For example, as can be seen in Table 5.1 Sleep & Fatigue was perceived as being most problematic during the early shift. In contrast, whilst swing shift 'late's' perceived Sleep & Fatigue to be the least problematic of the 5 areas covered, domestic and social life appeared to be affected the most, with Domestic & Family, followed by Social & Recreational, achieving the highest means respectively.

Table 5.1. Mean (SD) ratings* given for problem areas by shift type

	Early		Late		Night[f]
	Rotating without nights[a]	FWO[c]	Rotating without nights[a]	FWO[e]	Permanent nights
Sleep & Fatigue	2.867 (1.467)	2.667 (1.862)	3.750 (1.457)	5.000 (0.000)	3.524 (1.289)
Social & Recreational	3.600 (1.061)	3.500 (1.225)	3.217 (1.075)	4.000 (1.000)	3.286 (1.617)
Domestic & Family	3.509[b] (1.431)	3.800[d] (1.789)	3.051[b] (1.432)	4.667 (0.577)	4.048 (1.112)
Eating Behaviour & Diet	3.633 (1.340)	3.333 (1.633)	3.767 (1.294)	4.667 (0.577)	3.571 (1.248)
Health & Well-Being	3.533 (1.524)	3.500 (1.761)	3.850 (1.325)	5.000 (0.000)	3.762 (1.044)

*1 = extremely problematic; 5 = not problematic at all
[a]n = 60; [b]n = 59; [c]n = 6; [d]n = 5; [e]n = 3; [f]n = 21

Table 5.2. ANOVA summary (F values) of ratings for problem areas

	Shift Type (Rotating without nights, Permanent nights)	Sub Type (Early, Late, Night)	Shift Type x Sub Type
Sleep & Fatigue	1.004	2.307	0.189
Social & Recreational	1.808	0.525	1.496
Domestic & Family	1.533	0.342	1.072
Eating Behaviour & Diet	1.589	0.286	0.109
Health & Well-Being	0.578	0.980	0.407

p < .05; ** p < 0.01; *** p < .001

Eating Behaviour and Diet was perceived to be most problematic amongst those working the early shift as part of the FWO, whilst those working the late shift (both swing shift and FWO) rated eating patterns to be affected the least. The same pattern was also evident for Health & Well-Being with those working the early shift rating it to be the most problematic and those working the late shift rating it to be the least. Despite such variations, no significant main effects of shift type (Rotating without Nights vs. Permanent Nights) or sub type (early, late, night) were evident. This was also true of shift type x sub type interactions (see Table 5.2). However, planned comparisons showed a significant difference between early's and late's with regard to Sleep & Fatigue ($p<.05$), whilst for Domestic & Family significant differences were found for late's versus night's ($p<.05$), in addition to the shift types Rotating without Nights versus Permanent Nights groups ($p<.05$).

Thus in summary, a different pattern of findings emerged for each shift type, and indeed for different shifts within a single work pattern. For those working the early shift (both swing shift and FWO) Sleep & Fatigue was the most problematic, whilst for nightworkers and those working the late shift as part of the FWO, Social & Recreational problems were most pertinent. Swing shift 'late's' rated Domestic & Family life to be worst affected. At the opposite end of the scale, swing shift 'early's' rated Eating Behaviour & Diet to be least problematic, whilst for FWO 'early's' and night shift workers Domestic & Family life was least affected. Least problematic for swing shift 'late's' was Health & Well-Being, whereas for those working the late shift as part of the FWO, both Health & Well-Being and Sleep & Fatigue were least problematic.

Only two of those interviewed (both swing shift workers) used the extra boxes on the ranking sheet for additional problem areas. The first stated 'travel' as being extremely problematic on both early and late shifts, whilst the second highlighted 'overtime' as being extremely problematic, although this was true of the early shift only.

Before proceeding, a number of methodological issues must be addressed. Firstly, at the time of interviewing those working a rotating shift pattern were asked to complete two separate ranking sheets, one for each shift. Thus, a within subjects variable was used as a between subjects measure. The worry here is that rather than obtaining a picture representative of problems incurred by working *either* early *or* late shifts, the data may instead show the extent of shiftwork problems relative to the other types of shifts worked as part of a schedule. In retrospect it may have been more beneficial for rotating shiftworkers to have completed only one ranking sheet viewing the system as a whole rather than as two separate work patterns. Secondly, before discussing the interviews in more depth, it is important to note that as can be seen from Table 5.1 the mean ratings ranged from 2.667 through to 5 which, when related to the scale used, meant that the values fell within the 'quite problematic' to 'not problematic at all' range. Thus, caution must be taken when summarising the actual extent of problems experienced.

5.3.2. Interview Summaries

5.3.2.1. Sleep & Fatigue

Disrupted sleep patterns and the 'Sunday Evening Problem'

As expected one of the major problems experienced by those working a swing shift pattern was the constant changing from an early to a late routine. Although the most oft-mentioned advantage was the fact that the swing shift had in-built long weekends (when the shift changed from early to late), many found that the continual rotation affected their ability to establish a restful sleeping pattern:

> *"You just never get a good night's sleep. It takes me the best part of a week to get used to getting up at 4:30 in time for the morning shift. I know late's let you stay in bed for longer but I still wake up at around 4:30, sometimes I just can't get back to sleep and end up getting up anyway"* (no. 21).

When beginning a week of early's, the majority of those working rotating shifts with nights experienced what many of them termed the 'Sunday Evening Problem' whereby, unless they had worked overtime, the weekend spent away from work allowed them a greater degree of flexibility and usually involved an altered sleep pattern, characterised by a later risetime and bedtime (Monk, 1988). However, when Sunday evening arrived they became aware of the fact that they had an early start the following morning and found that, if they went to bed early in preparation, they lay awake for hour upon hour feeling frustrated. Moreover when they did manage to sleep it was typically very light and constantly interrupted, usually to check the clock, perhaps akin to the so-called 'apprehension stress' seen amongst marines on night watch duty reported by Torsvall *et al.*(1987). Indeed for most there was:

> *"the endless worry of sleeping through the alarm and arriving late at work"* (no. 9)

or the

> *"constant nagging feeling of having to wake up at a particular time"* (no. 67)

Consequently, many workers felt that, although they had made a concerted effort to decrease the feelings of tiredness and fatigue often experienced during the first part of the week, they nevertheless suffered. Rather than going to bed only to lie awake, other workers chose to stay up later in the evening, retiring only when they felt tired enough to be able to fall asleep. But even this strategy caused problems, for usually:

> *"What seemed like a good idea the night before, is a big mistake at 4:10 on a Monday morning when the alarm goes off".* (no. 33)

Rotating shifts were also characterised by carry-over effects from the opposite shift, with many reporting that they woke early in the morning both when working the late shift and at weekends during their rest days. As a result some found themselves feeling more tired as the week progressed, using their weekends to recuperate from the accumulation of sleep loss, only to leave them feeling aggrieved that their work intruded on their time even on days off:

> *" I feel like I'm caught in a catch 22. I'm tired on my days off and stay in bed to catch up but staying in bed just causes other problems 'cos I feel like I've wasted what little time I get away from work. All I seem to do is eat, sleep and work, what kind of a life is that? "* (no. 64)

Such a pattern of complaints has been described throughout the literature with the common finding that 'early' shiftworkers fail to advance their bedtimes appropriately (Åkerstedt *et al.*, 1991; Folkard & Barton, 1993). That the underlying circadian control of sleep influences such behaviour is suggested by the finding that a number of workers did, in fact, attempt to go to bed early but found themselves unable to get to sleep (Maury, 1991). According to Lavie (1986) the time at which they retired to bed meant that sleep was brought close to the forbidden zone, with the theory suggesting that sleep was easier for those who stayed up later in the evening because, at this time, the sleep gate opens and the propensity for sleep is at its highest. One argument against such a theory is that when those who attempted to phase advance their bedtimes were asked what time they retired to bed, responses ranged only very slightly, from 21:00 to 22:30 - values which fall into the 21:00-04:00 range of the sleep gate. Thus according to the theory, these workers should have had no problems sleeping.

The circadian disruption caused by a rotating work pattern offers an alternative explanation. The swing shift involved a discontinuous pattern of slowly rotating early and late shifts, a schedule which, according to some authors (e.g., Knauth *et al.*, 1982; Tilley *et al.*, 1982; Smith *et al.*, 1998) causes major disruption to the body's circadian rhythms, since the number of consecutive shifts worked can lead to partial adjustment of the sleep/wake cycle, but is also punctuated by a return to a 'normal' routine during the weekend, (Van Loon, 1963; Tepas *et al.*, 1990; Pilcher *et al.*, 2000), in effect placing them on a continuous rotation. It would seem reasonable to presume then that mechanisms of sleep, such as the sleep gate and forbidden zones, only apply to individuals whose sleep/wake cycles are relatively stable, and thus do not necessarily apply to workers on this type of schedule. An alternative explanation comes from Lavie *et al.* (1989) who found that the exact timing of the sleep gate may vary according to circadian type. This would explain why some workers were able to sleep following an early bedtime (M-types) whilst others found it extremely difficult, if not impossible (E-types).

Napping

Although some early shiftworkers resisted the temptation to relax around the house when their shift was over (choosing instead to visit the gym or go shopping) because of feelings of fatigue caused by irregular sleeping habits, the majority of swing shift workers reported taking a nap (both intentionally and unintentionally), a strategy often used by shiftworkers to top up on lost sleep (Knauth *et al.*, 1981; Härmä *et al.*, 1989), and therefore often termed 'split-sleeping' (Åkerstedt, 1998). However, in line with the 'prior wakefulness theory' (Åkerstedt and Folkard, 1996), those who took an afternoon nap found it to be of limited long-term benefit since it lowered the sleep propensity of their night sleeps and, therefore, further impacted the problem:

> *"I try not to take a sleep when I get home from work, but you know what it's like, as soon as you put your head down. I tried not napping for a week and slept better in the night so I know it's not good to do it".* *(no. 82)*

Although, as the quotation suggests, some were aware of the negative effects of such behaviour, the majority of those interviewed reported falling asleep whilst relaxing in front of the television. However, napping on the settee or in a comfortable chair does not always ensure a good sleep (and indeed is a practise advised against in some guidelines for shiftworkers, e.g. Wedderburn, 1991) and most reported feeling less than refreshed upon waking. Whilst such grogginess is typical of the sleep inertia experienced after waking (e.g., Dinges *et al.*, 1981a; Naitoh, 1981), it may also be indicative of napping in inadequate surroundings. For example, most of those questioned admitted that such naps were characterised by frequent awakenings either by others in the household or through feeling uncomfortable. Apart from the quality of naps, the utility of such 'catch up sleep' was also questioned with the most common remark being that sleeping in this way amounted to *"a waste of a day"*, by eating into the workers' leisure time:

> *"You wake up thinking 'where did the time go?' and not having done anything you wanted. Trouble is, if you don't have a cat nap in the afternoon, you waste the evening doing the same thing".* *(no. 25)*

Whilst sleep problems on the late shift were perceived as being less problematic than those on the early shift, it was, by no means, unproblematic. One of the biggest problems when working the late shift was the fact that many people carried over their early routine, waking early in the morning and having difficulty getting back to sleep, typical of the partial adjustment of the circadian system often seen in slowly rotating systems. Regardless of whether individuals stayed in bed or got up, almost all reported feeling extremely lethargic throughout the day.

Difficulties winding down from work

An added problem on the late shift was that, upon returning home from work, many found it extremely difficult to wind down. Although society expects people to retire to bed at around 10.00 or 11.00 at night, to the person who has just finished an 8h shift, relaxing enough to be able to sleep is very difficult. After all, a typical 9-5 worker does not come straight home from work and retire to bed, expecting to gain a good night's sleep. Indeed, as the literature suggests, the body has to be in the right state to sleep. Sleep occurs during the falling phase of body temperature, which begins during the evening hours, reaching its nadir in the early morning (Åkerstedt *et al.*, 1990; Lack *et al.*, 1996). Since those on the late shift arrived home late in the evening it may be presumed that, due to their level of activity, their body temperature would be comparatively higher than someone on the early shift who had finished work at 14:00. Thus in the same way that Åkerstedt and Folkard (1996) argued that afternoon naps can impair the main sleep because the recovery period starts from a higher level of alertness and reaches the sleep termination threshold earlier, physical activity taken too close to the main sleep may have the same effect since the body temperature of the 'late' shiftworker would have to decrease from a higher level, reaching the optimal temperature for sleep later.

An alternative explanation centres around the late workers' inability to use their leisure time as desired, which may affect their ability to relax enough to be able to sleep. After travelling from work the majority of late shiftworkers did not arrive home until around 22.30. By this time most of the family, and indeed neighbours, had gone to bed, especially if there were young children in the house. Thus certain activities, such as listening to loud music or DIY, that many people take for granted as a means of relaxation, are out of the question. Instead, most contented themselves with watching the television until they were ready to retire to bed, and described themselves as feeling *"very lonely and out of synch with the rest of the family"* *(no. 26)*. However, at the opposite end of the scale, a number of workers mentioned that they preferred to have this time after work for themselves, a finding which supports the idea that workers arriving home after a late shift rarely get to use their leisure time as desired.

Feelings of guilt, especially when their partner had stayed up to spend time with them, were common and, in such situations, workers tended to go to bed before they were ready as they felt *"selfish"* for keeping their partner awake. However, for those who stayed up until the early hours of the morning, another negative effect was incurred, for the worker who stays up late usually gets up late. Although many of these workers felt that they had had enough sleep, they also felt that they were wasting their time off during the day:

"I like staying in bed but hate the feeling of getting up and not having enough time to do the things I'd planned to do". (no. 44)

Work performance

In support of the ratings given for each problem area, the majority of those working rotating shifts with nights or FWO agreed that the early shift was the most tiring and consequently *"tends to drag"*. According to Tham *et al.* (1993) the sleep deficit incurred from the morning shift will increase with every morning shift worked, an effect that would result in the accumulation of fatigue throughout the week. Although fatigue was a major problem on this shift, some workers described themselves as feeling tired and groggy during the first part of the week only, suggesting that their sleep/wake cycles may have been adjusting appropriately, although it also possible that these workers were resigned to poorer sleep and were acclimatising to the feelings of fatigue.

Many of the base assembly operators were aware that, because the work they performed was monotonous and involved periods of inactivity, *"it's very easy to work on automatic pilot"* and described themselves as occasionally *"switching off"*. Although this was true for both early and late shifts, the former tended to be the most problematic for maintaining alertness with some respondents admitting that they had fallen asleep at their workstation, a finding reported by other authors (e.g., Torsvall *et al.*, 1989; Åkerstedt *et al.*, 1991). Such an outcome is perhaps not surprising given the truncation of sleep typical of early workers. Few nightworkers complained of problems with alertness or task performance, a finding that supports those who advocate that permanent systems result in better circadian adjustment.

Road safety

Apart from productivity, an important aspect of fatigue is safety, both during and after work hours. Indeed, according to Monk *et al.* (1996) accidents on the journey home represent the major risk of bodily harm in shiftworkers whose actual work may be inherently safe. In support of this, several workers identified travelling to and from work as being a major concern, especially those who had far to travel and did so on busy roads and motorways. Some of the experiences that were recounted serve to show how tiredness brought about by 'abnormal' schedules can have serious consequences. For example, one employee reported that he had had a severe accident, requiring hospitalisation, whilst travelling on the motorway to work for the start of an early shift, after literally having had a bad night's sleep and falling asleep at the wheel. Another respondent, who lived over 40 miles from the plant, reported that he often had to pull into a motorway service station on the way into and out of work during the early shift due to feelings of tiredness. On more than one occasion he had pulled into a service station after finishing an early shift with the intention of getting out of the car and walking around, only to wake up several hours later having fallen asleep in the car. Such cases also serve to remind us that those who have to travel from outside their area of work effectively have a longer shift, and thus incur more fatigue, when compared to those who live nearby, having to get up earlier and arrive home later.

Daytime sleepers

The lifestyle of the nightworker is far removed from that of the dayworker, for whilst the night is respected as a time for sleep, society continues its 9-5 pattern around the daylight hours. Thus the problems of the nocturnal worker are further compounded by the fact that society expects them to be awake during the day and at rest during the night, and gives little sympathy to those who deviate from this so-called norm. Contradictory to the literature (e.g., Koller *et al.*, 1978; Åkerstedt *et al.*, 1988), some of those interviewed found the ambient noise and light during the daytime comforting and even reported sleeping with the curtains drawn back and the windows open, although conditions were sometimes unbearable in the summer months because of increased noise levels and higher air temperatures. The family were also mentioned as a source of disturbance (Knauth *et al.*, 1972; Nachreiner, 1975), especially amongst workers with school age children who reported having responsibilities to attend to before they could take rest. Taking children to school or to appointments were high on the list, although having to walk the dog was also highlighted under family responsibilities. Constant interruptions by young children who have difficulty understanding why one parent goes to bed whilst the other is awake, and the worker interrupting sleeping time to eat a family meal were also frequently mentioned.

> *"Nobody else really understands what it's like to have to work odd hours. Besides life just goes on around you and unless you interrupt your sleep or personal time, the world just passes you by".* *(no. 12)*

An interesting point which surfaced during the interviews and which may help to explain the reduced quality of sleep is that, since the nightworker arrives home when the family are still in bed, most are reluctant to wake others in the household, be it partners, children, or flat-mates, and reported sleeping on the settee or an armchair, retiring to bed only when the rest of the house had risen:

> *"I wouldn't like to be woken up at 6:30 in the morning if I didn't have to get up for another hour. It would be nice to go straight to bed but you've got to think of everybody else"* *(no. 7)*

Not surprisingly, mid afternoon and early evening naps before work were frequently mentioned amongst nightworkers (Knauth *et al.*, 1981; Åkerstedt *et al.*, 1991; Rosa, 1993).

Adjusting to a daytime routine on days off

One of the biggest problems for the nightworker was changing their routine to a day orientation during weekends away from work, a behaviour pattern well established in the literature (Tepas *et al.*, 1990; Waterhouse *et al.*, 1992), and one which is fraught with problems. Many found the weekend away from work difficult in terms of both the ability to fall asleep at night and being awake and alert throughout the day, leaving them *"fighting tiredness"* and feeling that their leisure time was affected by their work schedule. Thus nightworkers were faced with the problem of how to cope with the change of routine:

> *"When I finish work on the Friday morning do I stay awake all day and go to bed in the evening, or do I go to bed in the day like usual but stay awake in the night instead? In my mind one's as bad as the other, neither seems to help".* *(no. 55)*

The majority of those interviewed attempted a rapid adjustment by taking a short sleep after their shift so that they were able to gain a relatively good night's sleep that evening. Some authors have argued that this strategy places the worker on a discontinuous rotating shift pattern rotating backwards on work days and forwards on days off (Van Loon, 1963; Pilcher *et al.*, 2000) and likened to working in San Francisco and returning to London for days off. Since the circadian system is extremely resistant to change, especially over the short-term, it is hardly surprising that these workers experience problems both getting to sleep at night and staying asleep during the day when not working.

Nightworkers also complained that they experienced problems when trying to adjust to the daytime routine during periods of holiday since it could take them several days to even begin to adjust, although some felt that they did not adjust at all during a two week spell away from work. This often meant that individuals had problems sleeping at night and translated into tiredness and lack of energy during the day, effectively *"spoiling the holiday for me and my family"* *(no. 27)*. Of course, the problems did not stop there since individuals experienced problems re-adjusting to their work routine on returning from holiday, with some estimating that it took them several weeks to begin to re-adapt.

5.3.2.2. Social & Recreational

The beneficial effects of corporate culture

Although many expressed the view that they missed out socially due to the hours they worked, most stated that the culture within the site created both a relaxed and friendly environment, and went some way towards easing the situation. Workers on the production lines often worked with the same team of individuals on a long term basis and so learned to build a sense of camaraderie and companionship with their colleagues. Sharing the same free periods and routines, many travelled into work and socialised outside of work together. Many workers perceived a high level of social support from both their co-workers and supervisors, which, according to some authors, can have a beneficial effect on shiftwork adaptation, as measured by mood and both psychological and physiological well-being (Thierry *et al.*, 1982; Revicki *et al.*, 1985; Bohle *et al.*, 1989, 1998). Indeed those who had been at the site longer expressed the view that working in this way made them feel like *"one of a team, not just your average shiftworker"*$_{(no.\ 54)}$ and gave them the opportunity to *"talk about problems with people in the same situation who understand what you're going through"*$_{(no.\ 2)}$.

Other facilities around the site also bolstered this social aspect. Coffee areas provided a relaxed and comfortable environment during break times, whilst the on-site gym provided access to sports facilities without the need for additional expense or travel. Recreational events, such as sports matches, cabaret shows and music events were also organised, with workers being positively encouraged to take part in both organisation and staging. Family barbecues in the summer months also helped to enhance the family unit by providing an opportunity for family and friends to spend time together. Regardless of the shift type worked, the majority of those interviewed spoke of the beneficial effects of these aspects of their work culture:

> *"Even though I don't like working shifts, the benefits of working for X are better than the bad things that come from it. If I could work days and still work for X I'd be a happy man"* $_{(no.\ 29)}$.

Recreation

Whilst such activities inside of work were appreciated and successful, activities outside of work were often comparatively impoverished. Those working rotating shifts without nights reported that they had been forced by their work schedule to give up a favourite pastime, ranging from playing in a band through to having to give up club membership, playing league sports and attending college courses. All were attributed to the fact that, because such events usually take place during the early evening and on a weekly basis, the rotating shift pattern only allowed them to attend every second week (Mott *et al.*, 1965; Folkard *et al.*, 1985; Schmeider and Smith, 1996). With most of their friends being inside of the workplace then, many workers reported feeling *"alienated from society"* and tended to put their *"social life on hold during the week"* (Mann and Hoffman, 1960; Gardell *et al.*, 1968; Fischer *et al.*, 1993). Although correspondence courses and certain hobbies which can be pursued from home are a good alternative, many felt too tired to partake in them following a shift, or simply stated that they would not enjoy staying at home pursuing solitary activities, preferring instead to go out and socialise.

On occasions when workers did engage in activities outside of work some found that, if working an early shift, they would leave early in order to prepare for the early start the following morning. Those on rotating shifts agreed that, since most events occur in the evening, the late shift was the most disruptive to social life, supporting both the data obtained from the ranking sheets, and studies which have estimated the value of 'leisure time units' in an attempt to calculate compensation for shiftwork payments (e.g. Wedderburn, 1981; Herbert, 1983). For example, one individual reported that:

> *"Working the swing shift completely obliterates any opportunity I have for a social life. I miss television programmes, sport, pub quiz nights, family parties, you name it, because I'm either working or too tired to enjoy them".* *(no. 48)*

The major advantage of the swing shift was in enabling workers to run errands and make appointments without having to take a day off. One worker explained that the in-built long weekends meant that they were able to take short breaks abroad without having to use annual leave to do so, allowing *"plenty of time to visit friends who live away from the area"* *(no. 62)*.

Seasonal differences

For those working early and late shifts the summer months were reported to be the most enjoyable. When working the early shift individuals could be at home for the afternoon, the time which many described as *"the best part of the day"*, and when working late's, they could have the morning to themselves and still arrive home in time to attend events, such as family barbecues. In contrast nightworkers stated that they found this time of the year particularly difficult to cope with, working during the coolest part of the day and sleeping during the hottest. In addition to the summer months being more noisy (being the time of the year that most people are outdoors), many nightworkers reported that they would prefer to be outside, giving up the time they should be sleeping to enjoy the sunshine:

> *"I just can't stay in bed when I know everybody else is out enjoying the day. It might mean that I lose out on sleep but it doesn't half make me feel better to be out there in*

the sunshine. I regret it later on when I get tired but it makes you feel better. I don't so much mind in the winter 'cos it's nice to be in a warm bed when everyone else is out in the cold. It's all psychological really isn't it" (no. 90).

Nightwork and recreation

Nightworkers experienced many of the same problems, missing out on family gatherings, sporting events, prime time television and so on. However, one of the most striking findings to come out of the interviews was the feeling of missing out and of being detached from society, the so-called 'marginal man' described by Walker (1985). Many highlighted the scenario that most people have finished work when they begin, and are in bed when they return home, giving them little opportunity to interact with the public in the way that dayworkers do:

"I can go to work and can come home and not see anybody on the way. It's a very weird feeling. It makes you wonder whether anybody knows you exist. I mean, you just imagine what it would be like to go to work in the middle of the day and not pass anybody on the way, it's just not natural. I know it sounds stupid, but at times I feel like nobody knows or wants to know what I do, like it's not important to them" (no. 49).

This was further compounded by the fact that nightworkers were reticent to pursue any type of activity during the daytime, being concerned about tiredness during their shift. Furthermore, they found it comparatively more difficult than those on the swing shift to run daily errands and make appointments, as doing so meant having to interrupt their day sleep in order to attend.

5.3.2.3. Domestic & Family

The quality of family life

Difficulties in spending, what the worker perceived to be, sufficient and quality time with their family was a fundamental problem. Those with children found shiftwork particularly difficult, and a common scenario when working the early shift was arriving home feeling tired. Spending time with the children rather then taking a nap meant missing out on vital rest. Thus early shiftworkers experienced conflict between their role as shiftworker and their role as parent (Mott *et al.*, 1965; Knight, 1995). As aforementioned these workers often felt that they had spoilt a family day out by having to return home early in order to get an early night. Thus not only did they experience role disruption, but also felt that shiftwork affected the quality of time spent in familial roles (Tasto *et al.*,1978; Staines *et al.*, 1984; Voydanoff, 1988).

Working the late shift caused similar problems. If the worker slept in late to make up the sleep deficit from the previous week, they missed out on seeing their children before they went to school for the day. This was further aggravated by the fact that, as mentioned earlier, the worker on the late shift did not typically arrive home until around 10.30, by which time the children were in bed. Thus the only interaction they had was *"kissing them goodnight and tucking them into bed"*. This led to the feeling, expressed by many, of missing out on valued domestic activities such as the day to day running of family life and sitting down with the family at mealtimes. Indeed, some were also concerned about the effect their absence had on their children:

> *"My kids are my social life. I like to have dinner with my wife and kids. It's a good time to catch up on the day's news and for me, it's the only time the whole family's together. I hardly see them when I'm working the late shift, they're all doing their own thing and come and go as they please, I feel like I miss out on a lot with them and wonder whether they're missing out in the same way"* (no. 62).

A proportion of the swing shift workers interviewed admitted that because the rotation of the shift pattern meant that the most problematic time occurred every second week, the situation was bearable giving them the opportunity to spend one week on their own and one week with the family. However, the overall feeling was one of guilt, in that workers felt that the hours they worked, and subsequent lack of time with the family, lowered the overall quality of domestic life for themselves, their partner and their children (Herbert, 1983; Shamir, 1983; Jackson *et al.*, 1985). Most tried to limit this by consciously setting aside time at the weekend when they could all be together. However, for many *"two days just isn't enough to catch up on everything that's happened through the week"* (no. 74).

Work/non-work conflict

Those with children found the swing shifts to be difficult in terms of meeting their domestic responsibilities as well as those at work, an indication of the so-called 'double burden'. During the early shift there were always domestic chores waiting for them when they got home which had to be completed before they could take a break or sleep. A common finding during the late shift was that a day's work had already been done before starting the shift:

> *"It's like having two jobs. Most of my friends lie in on late's but when you've got kids you don't get a chance to, there's always something to do before you go to work and, in my experience, plenty more to do when you get home. It's non-stop until I go to bed"* (no. 17).

Contradictory to the literature stating that women have to shoulder more of the domestic responsibility (e.g. Beerman *et al.*, 1981; Robson *et al.*, 1990), of those interviewed both males and females expressed similar complaints.

Relationship breakdown

When partners worked opposite shift patterns, available time together was severely reduced, regardless of whether they had children or not. However, where children were involved, a large majority of couples chose to work in this way as it ensured that at least one parent was with the children at all times and helped to reduce childcare fees. The biggest problem here, however, was that this was achieved at the expense of their relationships. The most common phrases used by interviewees when discussing this area were that:

> *"We're like passing ships in the night"*

and,

> *"We only ever get to spend time together at the weekend, in the week we're virtual strangers"*$_{(no.\ 23)}$.

Some couples enjoyed leading their separate lives in this way and appreciated having the house to themselves at particular times of the day. For others, not seeing enough of each other was a major problem. Several workers stated categorically that the breakdown of a past relationship was a direct result of their work pattern. Others admitted that they found it extremely difficult to develop a relationship outside of work (Carpentier, 1977, Koller *et al.*, 1978).

Nightwork and the family

Domestic & Family problems were ranked as being the least problematic by nightworkers compared to the swing shift workers, an impression supported by the interviews. Many nightworkers enjoyed this pattern of work because it enabled them to work through the night when the rest of the family were in bed, leaving the daytime free to spend with them, as well as having quality time to themselves. They were able to take their children to school in the morning before resting, were awake and alert by the time the children arrived home, were able to eat the evening meal with the family and even spend time with their partner once the children were in bed. Such findings support the likes of Jamal *et al.* (1982) and Colligan *et al.* (1990) who posited that fixed, as opposed to rotating, shift schedules, and permanent night shifts in particular, allowed workers to have more time with their families. Although there were some problems in gaining a restful sleep when children were at home in the daytime, most did not find this to be too much of a problem and were, on the whole, satisfied with their domestic situation.

5.3.2.4. Eating Behaviour & Diet

Rotating shifts and eating behaviour

In the same way that Tasto *et al.* (1978) reported that the eating habits of rotating shiftworkers differed according to the shift type worked, swing shift workers commented that the constant rotation of their shift pattern had resulted in irregular eating habits, both on work and rest days, with the alteration of their routines from early to late shifts forcing them to eat at different times of the day and night (Rutenfranz, 1981; Duchon *et al.*, 1990):

> *"I don't really have a regular eating pattern, it depends on what I'm working and how tired I am when I get home. You have to eat around your shift"* (no. 37).

The effect of tiredness on food intake

During the early shift many workers were reluctant to get out of bed to eat breakfast before going into work, instead preferring to remain in bed for an extra 30 minutes or so, having their first meal of the day from the canteen during their morning break. On returning home from work the majority reported either feeling too tired to eat or too tired to prepare anything, instead choosing high calorie, pre-packaged convenience foods that required little or no preparation but that were nevertheless comforting and satisfying. Crisps, biscuits and cakes were a favourite (Lennernäs *et al.*, 1994).

Feelings of fatigue and lethargy often continued for the remainder of the day and had an adverse effect on the consumption of food later on during the night. After having a rest most of those interviewed reported feeling hungry later in the evening. However, whilst some prepared a nutritious and balanced meal, others continued to feel too tired to cook and ate comfort foods or ordered take away meals. More worryingly, many missed out on what would usually be the main cooked meal of the day. Indeed, the majority of swing shift workers admitted that cooked main meals were only eaten during late shifts, being hardly ever consumed on early's. Most also reported that, as a consequence of their disrupted eating patterns, they snacked during the evening whilst relaxing in front of the television, with a high percentage having supper before retiring to bed. Such findings support those of Lennernäs *et al.* (1994) who found snacking, particularly on foods with low nutritional content, to play a major role in the nutritional behaviour of those on rotating schedules. It is quite intriguing however, that most of those who partook in this pre-bed meal were aware that this intake of food refreshed them and affected their ability to fall asleep:

> *"I don't know why I eat when I get home, it's probably just because I'm bored. My wife did ask me whether it may be comforting, that it makes up for not having any company when I get home"* (no. 1)

Late shifts offered a better opportunity to establish a more regular eating pattern, since many of the workers were able to eat both breakfast and lunch before going into work. In fact, because the late shift enabled them to get up later in the day most ate a combined breakfast and lunch at around midday. However, many of those interviewed found that eating well in the morning made them feel sleepy in the afternoon and affected their ability to work:

> *"I usually miss breakfast even though I'm hungry, otherwise I find myself falling asleep almost. Feeling hungry always keeps me awake"* (no. 84).

Typically, a cooked evening meal was eaten in the canteen during the main evening break, with many feeling that eating at this time was more satisfying and *"more sociable"*. Despite their consumption of food throughout the day, in accordance with those working the early shift, late shiftworkers reported snacking whilst relaxing before going to bed, mainly because they found it comforting and gave them *"something to do"* whilst they wound down from work.

Nightwork and eating behaviour

According to Takagi (1972), Folkard *et al.* (1985), and Duchon *et al.* (1990), disturbances of appetite are particularly prevalent at night, because although nightwork causes an inversion of a number of bodily rhythms, especially the sleep/wake cycle, the nutritional cycle does not show the same trend. In short, nightworkers typically retain their normal day oriented eating habits. In the present study, nightworkers shared many of the irregular and unhealthy eating habits as those working rotating shifts, yet as a direct result of working, what many termed, *"unsociable hours"* additional problems were also experienced. A common complaint was having to interrupt their day sleep to join in with a regular family mealtime (Takagi, 1972), often eating at times when they were not at all hungry. One individual explained the he did not feel that he could ask for something different from the rest of the family when his partner had prepared the meal especially, placing his feelings in context by asking: *"How many day workers would like to get up in the morning to face a roast meal for breakfast?"* (no. 16).

Many nightworkers at the site also reported omitting both breakfast and the midday meal in an attempt to prolong their sleep (Takagi, 1972) but instead snacked through the day and moreso during the shift in an attempt to stay alert, eating only a cooked meal in the canteen at the 'dinner time' (which in reality was 01.30 in the morning). Indeed, Debry *et al.* (1972) suggested that disturbances of appetite were associated with a dislike of having to eat at unusual times. Such irregular routines also tended to carry on through the weekend with individuals complaining of having to eat at different times than the rest of the family and feeling hungry at all times of the day and night.

Caffeine intake

Almost all employees admitted that the nature of the work they performed meant that, in comparison to rest days, they consumed vast amounts of coffee, tea and caffeinated soda drinks, mainly as a means of maintaining alertness (Tepas *et al.*, 1989). Many also admitted that the coffee areas were often the first port of call in relieving the monotony of the lines by stretching their legs. Indeed, of those interviewed, all reported that if the drinks were not free or as accessible, they would not consume as much:

> *"In work I have about 9 or 10 cups of coffee but at home I only ever really drink say 2 or 3. I suppose it's because I get tired more often in work and coffee's supposed to wake you up, although I think it's more to do with being bored, you know when you need to get up and stretch your legs, going to the coffee machine is a good excuse, if nothing else it gives you somewhere to walk to"* (no. 31).

Such findings have important implications for the sleep problems noted earlier in the chapter, since both Tepas (1982) and Dekker *et al.* (1993) reported that even moderate amounts of caffeine could last for between 5-8 hours after ingestion and may delay the onset of sleep.

Break systems

Regardless of shift type, break systems were the source of many complaints, such as "*eating for the sake of eating*" and "*feeling forced to eat when I'm not even hungry*" due to both the timing and the length of the breaks on each system. Most complaints were from those working on the assembly lines, since employees in supporting roles had more flexible break patterns. In terms of the length of breaks, most commented that 20 minutes was simply not long enough to walk to the canteen, choose their food, queue up, pay, and still have enough time to sit and eat, with some reporting having just 5 minutes or less to eat their meal, and "*bolting the food down*" only to feel bloated and sluggish on returning to work. Some workers even reported having to leave their meals due to insufficient time. Rather than rushing their breaks, others simply missed out on a meal altogether and chose instead to sit in the coffee area, substituting a meal for a cup of coffee and a chocolate bar from the vending machines. Weight problems perceived as being due to these irregular and unhealthy eating habits were a major concern.

Canteen facilities

Whilst in general, the canteen facilities offered at the site were appreciated by the workers, a number of those interviewed (mainly those with speciality diets) did express their dissatisfaction. For example, certain members of the workforce were required to eat a dairy free diet, a regime not catered for in the canteen. These individuals felt offended that they had to provide their own food, which, when working the early shift especially, necessitated getting up earlier than most in order to prepare their meals in advance.

5.3.2.5. Health & Well-Being

Chronic fatigue, irritability and stress

A constant theme throughout the discussion so far has been the feelings of tiredness felt by workers, causing them to lack both the motivation and energy to pursue *"a normal life"* outside of work. This often led onto a sense of missing out on life, with many feeling that all they managed to do on a day-to-day basis was to *"eat, sleep and work"*. Furthermore nearly all of those interviewed, regardless of whether they had identified problems in other areas, reported feeling *"snappy"* and *"down in the dumps for no reason"* on a regular basis. Repetti (1989) suggested that such feelings can result in a vicious cycle of events, feeding back into the shiftworker's problems and affecting the worker's relationship with family and friends. Amongst those interviewed irritability with partners and family members served only to cause further problems:

> *"I know I shouldn't snap at everybody, it's not their fault, but at the same time I don't think they realise how hard it is, but then you could also argue that all they see is me being irritable"*$_{(no.\ 3)}$.

Stress was also a prominent health complaint, noticeably moreso amongst supervisors, which the vast majority attributed to organisational factors such as the pressures of overtime or having to meet deadlines (Cobb, 1976; Repetti, 1993b). Common symptoms were being *"overemotional"*, *"easily brought to tears"* and even suffering panic attacks. In some cases problems were considered to be severe enough to warrant treatment by a GP.

The working environment

Not unexpectedly, considering the type of work environment, many of the workers reported having minor infections such as colds and flu-like symptoms on a regular basis. The most common explanation for this however, was the use of air conditioning within the building and the theory that such symptoms could be attributed to the *"recirculation of bacteria and stale air"*. Feeling *"muzzy-headed"*, and suffering regularly from headaches, migraines and eye strain were common complaints, attributed to both the nature of the work and use of artificial lighting in the building.

Gastrointestinal and cardiovascular complaints

As are often reported amongst samples of shiftworkers, gastrointestinal problems such as indigestion, heartburn, feeling bloated, stomach ulcers, poor appetite, nausea, stomach upsets and constipation (Rutenfranz, 1982), in addition to cardiovascular problems such as high blood pressure (Michel-Briand *et al.*, 1981), hypercholesterolaemia (Orth-Gomer, 1983; Romon *et al.*, 1990), palpitations, dizziness and history of heart attacks in older males (Koller, 1983; Knutsson *et al.*, 1986) were identified during the interviews. Such complaints are often contra-indications of problems suffered in other domains (e.g., insufficient sleep, irregular eating habits, unbalanced diet, family problems, and social adjustment), as well as the added stress and strain that often accompanies them. Indeed, in discussing such complaints the majority of those interviewed perceived them to be a result of one or more of their problems in other areas.

Depression

According to Johnson *et al.* (1992) depression in the workforce is a significant problem, a statement supported by the present study. Depression was undoubtedly the prevailing health complaint across all shift types, but noticeably moreso amongst those working the night shift (Costa *et al.*,1981). For example, 43% of those working the swing shift or FWO patterns complained of feelings of depression, whilst in nightworkers this figure was 78%. Of those who admitted to feeling depressed, a strikingly high proportion (65%) were being treated by their GP. This was true across all job roles. Of course, caution must be used in interpreting these findings since they are based purely on subjective data, and as such, depend upon what individuals believe to be symptoms of depression. However, since 39% of those interviewed had children, such findings have important implications in the light of research which suggests a possible link between paternal depression and the development of emotional disorders amongst the children of shiftworkers (White, 1959; Hammen, 1988; Cohn *et al.*, 1992).

Another interesting finding from the night shift was the prominence of Seasonal Affective Disorder (SAD), reported by 26%. When placed into context this is not surprising, since the nightworker is most active during the night and sees little of the daylight hours. Accordingly, such problems were reported to be worse during the winter months when the periods of light are much shorter. Two-thirds of those who reported suffering from SAD were undergoing light therapy or counselling at the time of the interviews to relieve their problem. Others were attempting to change to a rotating shift pattern.

Exercise

Due to feelings of constant tiredness many of those at the site had given up regular exercise. A high proportion admitted that before beginning shiftwork they used to *"walk everywhere"*, whereas since beginning shiftwork they had resorted to using the car for even very short journeys. Others had tried to take advantage of facilities at the site by using the on-site gym but found that they were simply too tired, lacking the energy and motivation to maintain the regime:

> *"For a while I made sure that I put out my swimming costume and towel by the front door so all I had to do was pick them up and go straight back out. I knew that if I didn't, I'd sit down and sleep on and off for the rest of the day. It worked for a little while, but it didn't last"* *(no. 44)*.

Others had given up membership of sports teams and playing league sports because the shift pattern prevented them from attending on a regular basis (Mott *et al.*, 1965; Andersen, 1970).

Safety and convenience in getting to and from work was another factor affecting the amount of exercise taken by workers at the site. Lack of public transport in the early hours of the morning meant that many used a car because they were either unable, or reticent, to walk from home. In relation to the surrounding communities, the site was not central, and therefore many lived too far away to be able to do anything but commute. Reported weight problems were perceived to be either caused directly or, at the very least, exacerbated by a lack of exercise.

Risk behaviours

As a way of coping with the day to day strains associated with shiftwork many reported that they tended to smoke more during work compared to rest days (Thelle *et al.*, 1976; Knutsson *et al.*, 1988; Green *et al.*, 1990). Smoking was perceived to be a very social activity amongst workers and many found themselves joining others as a way of relieving the monotony and stress of work (Knutsson *et al.*, 1988). Whilst most were aware of the adverse effects of smoking, and indeed expressed a wish to give up, the majority admitted that they found it to be an effective way of coping with their problems on a daily basis, and was a coping mechanism that required little effort.

Temporary workers and stress

A common finding during the interviews was the bitterness and resentment expressed by temporary employees at the added stress and strain involved in being employed on a temporary basis. Many complained that they consciously worked harder to present a good image of themselves, feeling that they were being constantly *"watched for every little mistake"* and unable to take 'unofficial breaks' in the way that those on a permanent contract were able to:

> *"If I go on an unofficial break with a permanent employee I know that if we get caught I'm the one who'll get in trouble"* (no. 35).

With symptoms of anxiety, stress and strain appearing to be more pronounced in temporary employees, it certainly suggested that both the threat of unemployment and the lack of supervisory social support for these individuals added to the problems already suffered as a result of shiftwork (Warr, 1983; Burchell, 1994).

5.3.2.6. Summary of Key Themes

Since the major aim of the present study was to highlight those areas that should be included in the subsequent questionnaire, the interview summaries were analysed for themes that were either recurrent, in the sense that they had been expressed by more than one interviewee, or, if not stated explicitly, were suggested to be strongly linked to other problem domains. Table 5.3 lists the recurrent themes according to each of the 5 key areas. From this information we can begin to build up a profile of the problems commonly experienced by those at the site that can then be used to guide the selection of measures.

Attempting to generalise from the pattern of findings, the common link between each of the problems experienced by those working the swing shift was the constant rotation of the shifts and the concomitant inability of those working this pattern to adjust their routines in the short-term. Thus, problems experienced as a result of working the early shift, such as having to wake up and get up early in the morning, tended to affect the individual when working the late shifts as well as during days off, a situation indicative of the circadian system's resistance to adaptation in the short term. In the same way, working the late shift meant going to bed later and affected the workers ability to drop off to sleep when they tried to go to bed early on the opposite shift.

This constant rotation of shifts also affected such areas as eating and diet with the majority complaining that, due to the shifting of meal times with the early and late shifts, and often in combination with the constant feelings of tiredness felt by these workers, this resulted in both poor and irregular dietary habits, missing out on meals altogether, or relying on pre-packaged convenience foods and take-aways. In contrast, the profile of problems typical of the nightworker could be assumed to stem from engaging in a lifestyle contradictory to that set out by society. For example, nightworkers who experienced sleep problems attributed it to the fact

Table 5.3. Recurrent themes by problem area

Sleep & Fatigue	• Inability to adapt to changing sleep routines due to the rotating shift pattern • Clock watching on the early shift • Difficulties falling asleep before the first early shift of the week • Inability to wind down and fall asleep following the late shift • Waking up early and inability to get back to sleep on the late shift and rest days • Napping affecting night sleep • Insufficient sleep • Disturbed daytime sleep following a night shift • Interrupting daytime sleep to join in with family meals and other activities • Feelings of tiredness on work and rest days • Road safety
Social & Recreational	• Not being able to maintain hobbies and pastimes • Feelings of alienation from society • Impoverished social life
Domestic & Family	• Not seeing family, especially children and partners • Little or no quality time with family • Working opposite shift to partner for childcare • Difficulties starting and maintaining relationships • Home/work conflict creating feelings of non-stop work • Little or no support from the family • Irritability with family
Eating Behaviour & Diet	• Irregular eating habits • Tiredness causing lack of appetite and no motivation to cook • Meals nutritionally unsound • Length and timing of breaks inadequate • Snacking, especially following a late shift • Eating at inappropriate times in nightworkers • High intake of caffeinated drinks
Health & Well-Being	• Chronic fatigue and lethargy • Tiredness leading to irritability • Gastrointestinal and cardiovascular complaints • Stress • Depression and SAD • Lack of exercise

that they had to sleep in the daytime when noise and heat were higher. Valuable sleeping time was given up to be able to join in with the family meal, often the only opportunity the nightworker had to interact with their family. Adjusting to a daytime routine during days off was also a problem, since a concerted effort to stay awake during the daytime was required at the weekends. However, rightly so, most of the nightworkers complained that the two days of the weekend did not allow sufficient adjustment to be made and often resulted in them experiencing tiredness and disrupted sleep on returning to work.

5.3.2.7. Interaction of Problems

Another fact that became clear from both talking directly with the shiftworkers in the interviews and in attempting to generalise from the findings was that the problems experienced tended to interact with one another, leading to complex and interwoven relationships, and consequently difficulties in employing the appropriate coping strategies. For example, disturbed sleep during the night sleep of early shiftworkers led to napping in the afternoon when they had returned home from work, a practise that affected their ability to sleep at night. Although the direction of causation is difficult to verify, Figures 5.1a, 5.1b and 5.1c show a simplified generalisation of the problems experienced by workers on the early, late and night shifts, respectively, and how these problems may interact with one another.

As Figure 5.1a illustrates, the 06:00 start typically resulted in the night sleep of the early shiftworker being truncated because many failed to phase advance their bedtimes appropriately, instead going to bed late in the evening despite the fact that they had to rise at around 04:30 the following morning. Worries about oversleeping and going back to sleep after turning off the alarm affected sleep quality, with these workers complaining of sleep that was typically light and disturbed. This sleep loss gradually built up throughout the week resulting in a cumulative sleep deficit characterised by high levels of fatigue and impaired alertness on both work and rest days, the latter of which had implications for road safety in commuting to and from work.

As a counter-measure most workers took a nap on returning home from their shift, as has been commonly noted in shiftwork studies. Whilst this may be an effective way of topping up on lost sleep, it often led to further problems, for napping in this way left many feeling that work was encroaching on their personal leisure time as well as time spent with family and friends. This resulted in a cyclical relationship between impaired social life and irritability.

Fatigue also adversely affected social and family life with many of those interviewed complaining that they found themselves falling asleep throughout the day as well as being too tired during the evening to be able to go out and socialise with friends. This tended to be the case on both work and rest days. Napping during the afternoon following a morning shift also resulted in many workers missing out on a midday meal. Consequently most ended up snacking through the evening to curb their hunger that, too close to bedtime, affected their ability to sleep by making them feel more alert. On many occasions naps were taken too close to bedtime leading to problems in both getting to, and maintaining, sleep, resulting in the all-too-familiar problems of high disturbance and truncation of rest.

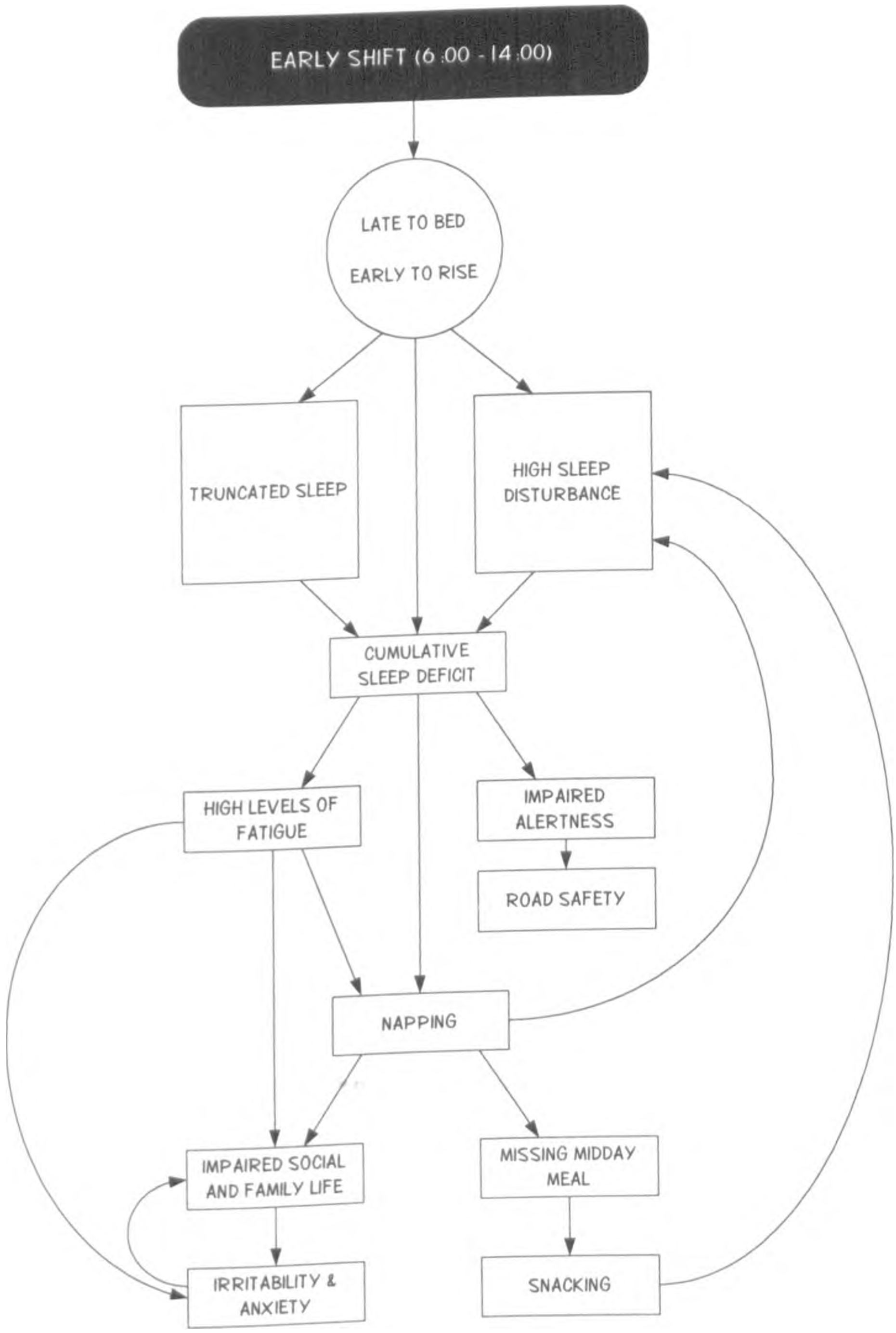


Figure 5.1a. Generalised interaction between problems experienced on the early shift

As Figure 5.1b illustrates, the major problems regarding the late shift were the late finishing time and the subsequent distribution and quality of leisure time. The fact that the late shiftworkers' leisure time occurred during the morning meant that individuals could not do too much or go very far being ceaselessly aware that they had to be back by a certain time to be ready for the start of the afternoon shift at 14:00. Many of those interviewed complained that the morning was spent *"clock watching"* and *"waiting around to go to work"*, and that doing so amounted to *"a waste of a day"*. An additional problem of morning leisure time was that friends and family are generally at work or school during this time and so are not accessible. Children have gone to school by the time the worker has got up and are in bed by the time they return home, partners are usually also in bed by this time, and the worker has missed out on eating the evening meal with the family (typically the only time during the day when the whole family is gathered together).

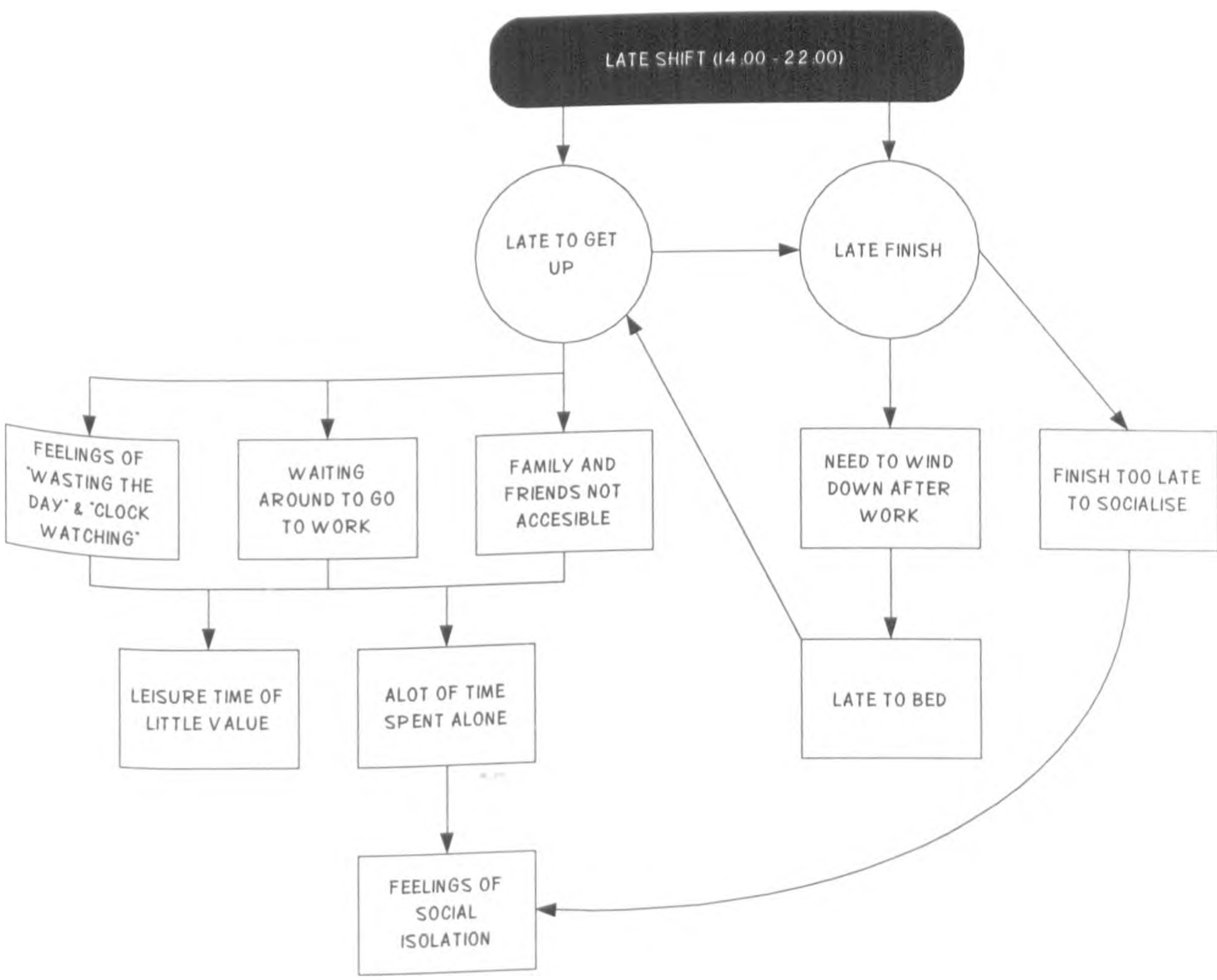


Figure 5.1b. Generalised interaction between problems experienced on the late shift

This meant that the late shift worker tended to spend a lot of time alone, which in some cases led to feelings of alienation and isolation from those around them. Thus in general, those on the late shift found their leisure time to be of little value when compared with the opportunities allowed to them during evenings or weekends.

As can be seen in Figure 5.1c, the major problem facing the nightworker was the temporal shifting of work and sleep. Sleeping in the daytime affected both the amount and quality of sleep gained since workers not only had to contend with the extra noise and heat typical of the day but also had to interrupt their sleep in order to join in with the family meal, to run errands, or attend appointments. Such difficulties led most often to feelings of fatigue and to bouts of irritability.

The main complaint by nightworkers was that they had little exposure to daylight, supported in part by the fact that many of those interviewed suffered from SAD and depression, which workers themselves attributed to this problem. However, leading a lifestyle opposite to that led by, what the nightworkers themselves seemed to think were, the majority of society, meant that they lacked the normal day-to-day interaction with those around them, going into and out of work when most people, and especially family and friends, were at home. As was the case with those working the late shift, this very often led to feelings of isolation.

Nightworkers also complained that their appetite was affected by their work routine, since their breakfast time coincided with the family's lunch or dinner time and their evening meal actually came at around 1:30 in the morning during the morning break. Due to this, many of those interviewed missed out on meals, choosing instead to snack throughout the day, both in work and at home. Perhaps as a result, gastrointestinal complaints (e.g., indigestion, stomach ulcers and bouts of diarrhoea and constipation) were common amongst this group.

One of the most fundamental problems experienced by nightworkers across the board was that, in order to lead a so-called 'normal' life at weekends, they had to adjust to a daytime routine in a very short space of time. Since the circadian system is extremely resistant to change, this lack of adjustment simply added to the worker's problems, with many suffering from short sleep duration, disrupted sleep and, consequently, fatigue, both during the following week and the weekend itself.

Of course the problems experienced by shiftworkers, the way in which these problems interact with one another and the choice and effectiveness of coping strategies employed by individuals

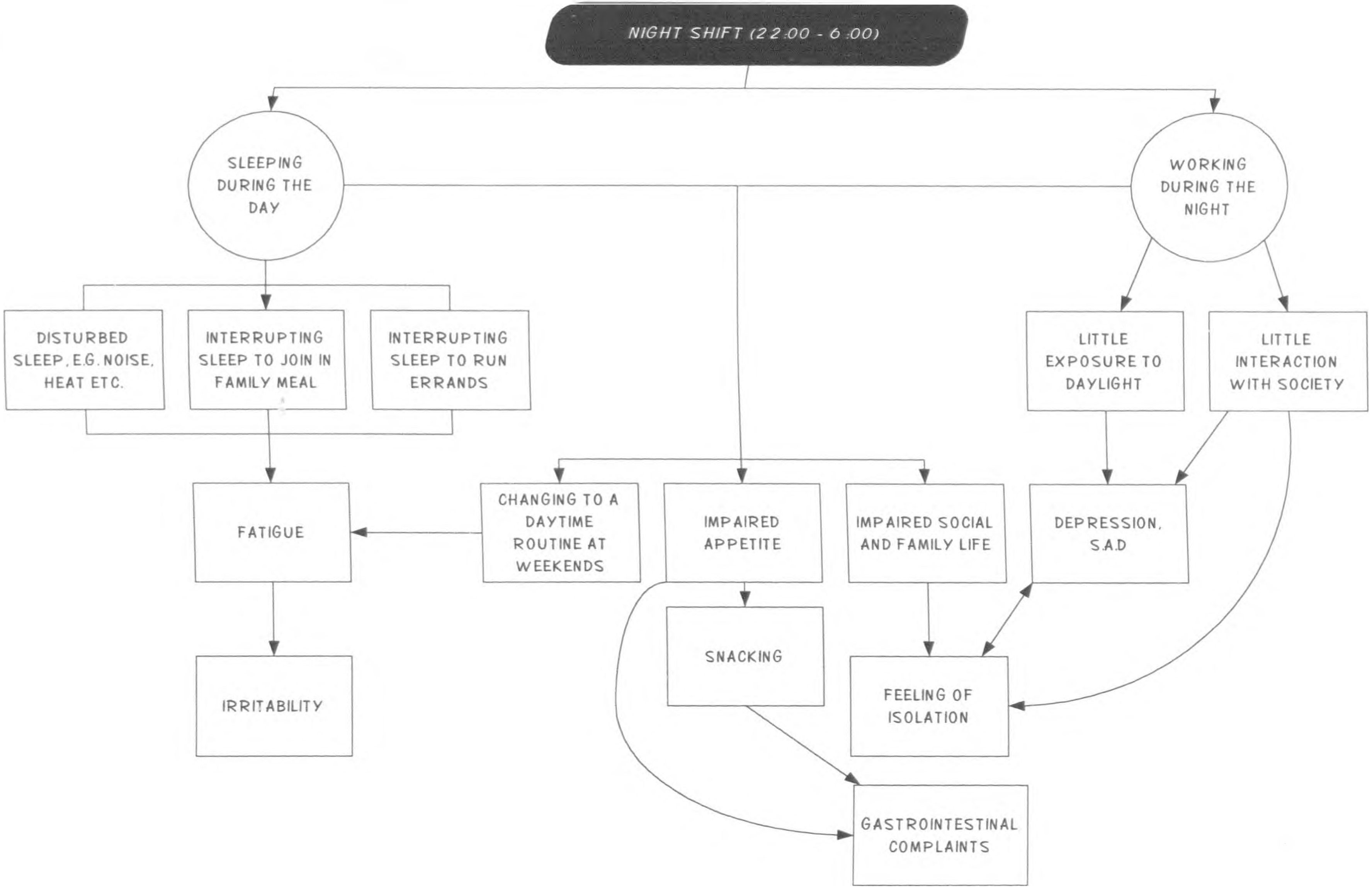


Figure 5.1c. Generalised interaction between problems experienced on the night shift

to deal with them will depend on many factors. Marital status, number of children, personality, age, and gender, may all affect the way a person adapts to shiftwork. Such factors will be addressed in the questionnaire study that follows. However, in the same way that models of shiftwork tolerance generalise the state of research findings, generalising the findings from the interviews in this way allows us to focus on those areas, and particular problems within them, that are commonly experienced by a workforce. In this way they present a starting point in assessing measures that can be introduced (such as changes to the shift systems used, alterations to the break systems, or the use of educational packages in helping workers to cope) in order to make the site more supportive and worker-friendly.

5.3.3. *Shift Preferences*

As stated at the start of this chapter, an intention of the research was to assess whether there was a need for change in the work patterns adopted by the site. Each interviewee was asked at the end of each session: "Given the choice, would you prefer to stay on the same shift system as you currently work or would you change it in some way?" to determine whether they were satisfied with their current work pattern. The findings were then used to initially assess the feeling amongst the workers as to whether they would be accepting of a change and whether they could provide some suggestions as to ways in which the shift patterns currently in use could be changed for the better, both in terms of reducing the problems suffered by workers as a result of shiftwork, and as a means of improving both morale and productivity at the site. Table 5.4 shows the shift preferences in terms of the percentage who voted for each of the options. No options were given to the individuals, therefore, those listed in the table were those generated by the interviewees themselves.

Table 5.4. Shift Preferences

Shift Preference	%		
	Rotating without nights	Permanent nights	FWO
Stay the Same	49.25	73.91	100.00
Permanent Early's	20.89	-	-
Permanent Late's	13.43	4.34	-
Swing Shift	-	13.04	-
Night Shift	-	-	-
Permanent 09:00 - 17:00	4.47	8.69	-
Don't Know	4.47	-	-
Permanent 08:00 - 15:00	1.49	-	-

Clearly, despite the problems identified, there was an overwhelming preference to continue working the current shift pattern, amongst 49.25% of the swing shift workers, 73.91% of the night shift workers and 100% of those on the FWO. This supports the likes of Nachreiner

(1975) who found that, despite the dissatisfaction of shiftworkers with their work patterns, this was not accompanied by a desire to change. Since the length of shiftwork experience was not taken as a possible mediating factor in this analysis, whether the results were due to the fact that these individuals had worked the particular systems for a greater length of time than those who would prefer to change their work patterns in some way was not addressed. However, evidence from the wealth of literature suggests that more experienced workers would be expected to have organised their lives and established routines which suited them personally, experiencing fewer problems as a result (e.g. Haider *et al.*, 1988). It was certainly noticeable throughout the interviews that fewer problems were reported amongst those who had more experience at the site and with shiftwork in general. An additional reason behind this preference may also be the fact that individuals were reticent to change from their current schedules since they offered the highest financial incentives in the form of 'shift premiums'. Many admitted that whilst they had been told by the company to discount the shift premiums from their base salary, they would find it extremely difficult to cope without the extra income:

> *"People organise their lives around how much they earn, the more you earn the more you spend. Everyone would like a higher salary but you get used to how much you earn and it never seems to be enough"* (no. 42).

Of those working the rotating shift who would change to permanent early's, the over-riding reason put forward was that they disliked the feeling of *"hanging around for the late shift"*, *"constantly clock-watching"* and *"feeling robbed of my evening"* and so by working the morning shift it would *"get it out of the way for the rest of the day"*. In contrast, those who showed a preference for permanent late's were those who disliked getting up early and found themselves to be extremely tired when working the swing shift pattern. By working permanent late's it would allow them to establish a routine, thereby enabling them to gain restful and recuperative sleep. These individuals also enjoyed the late shift more because it allowed them to have a period of time to themselves on either side of their shift. Establishing a routine and spending more time with their partner were also reasons given for those with a preference for permanent 09:00 - 13:00 and 08:00 - 15:00.

The majority of those nightworkers who would have preferred to change their current shift, wished to do so in order to spend more time with their partner and family, to feel less cut off from society, and to be able to establish a sleep routine by sleeping during the night rather than during the daylight hours. Many of those interviewed explained that they disliked sleeping separately from their partners and found doing so very lonely. Since this provides one of the only opportunities to share quality time together, for many working couples who spend the majority of the day apart, it is not surprising that many of the permanent nightworkers craved this opportunity.

Because those working the FWO scheme had chosen to work on a particular pattern, and all showed a preference for continuing to work their current shift schedules, each was asked why they had chosen the FWO. Both females in the group mentioned childcare as their main reason, whilst for the males, a variety were offered. For example, for one male the pattern of work allowed him to have an extra day off every fortnight as well as having a Friday off when working a week of late's. Exercise was mentioned by two participants, one of which stated that he was an 'early bird' and got up early to go to the gym, whilst the other mentioned that working the FWO allowed him to take regular exercise and establish a regular sleep pattern. Problems with having to share a car, and the opportunity to spend more time with his wife were highlighted as the primary reason by one male, whilst another had just purchased a house in need of renovation and wanted to have the time to work on it.

5.4. Discussion

The primary aim of the interview stage was to investigate the aetiology and management of problems experienced by shiftworkers. Whilst the results show a certain patterning of problems that could be related to shift type it is also very obvious that the actual problems experienced, their severity, and the way in which they are perceived, form complex interactions that may be as much a part of the situational and individual differences of those interviewed as it is a reflection of fundamental problems with the shift patterns themselves. For example, although the findings supported the recognition of major problem domains as identified in the literature, the ranking of problem areas in order of severity showed a different pattern depending on shift type. For morning shifts, worst to least affected were: sleep, domestic and family, health and well-being, social, and diet, whilst for the late shift, sleep was relegated further down the list. Here domestic and family and social life were worst affected whilst diet and health and well-being ranked as less affected. For nightworkers a different trend was seen. Here outcomes were ranked (worst to least) in the order: social, sleep, diet, health and well-being, and domestic and family. Thus, although few additional outcome measures were identified amongst those interviewed, when ranked in order of their impact, shift type was an important mediating factor. Of course, such observations are limited by the fact that participants' existing state of health or their individual characteristics were not considered at this stage.

In visualising the interaction between outcomes, responses fitted well with the approaches taken by the models of shiftwork tolerance. Some of those interviewed argued that shiftwork was the direct cause of the problems they experienced, identifying few, if any, interactions between problem domains, similar to the approach taken by the likes of Åkerstedt and Fröberg (1976), Knutsson (1989) and Rutenfranz (1976). In contrast others visualised their experiences as the interaction between areas, similar to the approach taken by Bunnage (1984) and Monk (1988b). Finally, in line with the likes of Monk (1988b), Knutsson (1989), and Olsson *et al.* (1990), a number of those interviewed expressed the view that the problems they encountered were related to the way in which they were approached and the coping strategies used. Despite such similarities it is interesting to note that those shiftworkers who took part in the interviews did not mention the possible mediating influence of modifier variables such as age, circadian characteristics, personality, or work related factors. This was perhaps due to the nature of the interview itself in that it concentrated on eliciting *outcomes* of shiftwork, rather than identifying possible *modifier* variables. Moreover, the interview plan was such that individuals were not prompted to think about factors that affected their experiences of shiftwork. Although it is difficult to conclude that the shiftworkers themselves gave little importance, or were unaware of, the possible influence of modifying variables, the fact that none of those interviewed mentioned them suggests some divergence of understanding between those who work shifts and those who study its effects.

The two remaining aims were to establish a rapport with participants, to motivate them to get involved in later stages of the project and, more importantly, to communicate to them early on that the project was aimed at the 'individual', rather then the 'organisational' level. An overwhelming majority of those interviewed were sceptical as to the utility of the project since filling out questionnaires and having group meetings were a typical part of their work culture, and a practise which rarely ended in change. However, most of those interviewed had never been given the opportunity to discuss the problems they experienced as a result of working shifts, nor given the opportunity to take an active role in suggesting how the shifts should be organised, and were more than happy to discuss their personal problems in detail. Whilst it is impossible to say whether these individuals were motivated to be involved in the project in the long term, all of those who volunteered for the present phase also volunteered to take part in the questionnaire study that followed.

Despite the overwhelming preference expressed by the respondents to remain working the same shift pattern, results of the present study do suggest that changes to the present work schedules may be of benefit to the workers. Indeed, many of those interviewed were able to make a suggestion for overcoming the problems faced by themselves and their colleagues. The most common was to delay the shift start time by one hour, believing that an extra hour's sleep for the early shift workers would make *"the world of difference"* in terms of reducing fatigue both on and off the shift, yet would make very little difference in arriving home one hour later. With regard to encompassing this change on the late shift many admitted that arriving home one hour later than normal would cause few problems since *"Everything is beginning to close and people are beginning to go home by the time we finish work anyway"* (no. 62).

An additional benefit of beginning the early shift an hour later was the ability to commute to work. A major complaint amongst respondents were the difficulties experienced in getting to work for the 06:00 start. Trains and buses did not run at this early hour, meaning that some were forced to rely on fellow workers or their partners for transport. However, the latter option tended to cause more problems because most were reticent to wake their partners at 05:00 and encroach on their sleep. Nightworkers also agreed with the suggestion of a delayed start time to the shift. For these individuals an extra hour at home in the evening before their shift would allow them to have more quality time with their families, but make little difference to their sleeping or eating habits.

Despite the insight offered by these results, the methods used in collecting the information suffered from a number of methodological weaknesses that must be born in mind when interpreting the findings. The most pertinent of these was the nature of the interview itself. Unlike structured approaches, whereby all participants are asked the same questions in the same sequence, the technique used in the present study was intentionally informal. This was to ensure that interviews were led by the shiftworker rather than grounded by theory. One disadvantage of conducting interviews in this way is that interviewer bias may have affected the responses given. Thus, although the interviews were open ended, the interview plan contained specific problem domains that were used to prompt the respondent if they had not been mentioned. Furthermore, the one-to-one basis of the interview may have affected the quality of information obtained since interviews, by their very nature, are often unnerving, and thus has obvious implications for the validity of the information collected (Latham and Saari, 1984).

Secondly, since only 90 interviews were conducted, the insights gained do not necessarily represent either the shiftworkers at the site nor the shiftwork community as a whole. Furthermore, all of those who took part in this stage volunteered to do so, yet their underlying motivations were not considered. It may be the case, for example, that they represented the proportion of the population who experienced more problems and could therefore be classed as 'poor tolerators', therefore reflecting a self-selected sample. However, the fact that several of those interviewed admitted to suffering no problems in any of the domains partly challenges this assumption. In the same vein, it could also be argued that the sample contained a number of individuals who participated because they were interested in the research, and may have represented those who were prepared to understand the aetiology of their problems in order to take steps to cope more effectively. Moreover, because individuals were approached by their line managers and supervisors and asked whether they would like to volunteer, some may have felt pressured into doing so. Similarly, because interviews were conducted during company time some may have used this as an opportunity to have a break from work. Therefore, the way in which individuals were recruited raises questions as to whether they were a representative sample of the population, since all those who attended were people who *wanted* to volunteer, for *whatever* reason. Without taking a truly random sample of people it is impossible to conclude whether they were above or below the average shiftworker at the site in terms of the type and severity of problems they experienced.

Another possible complication in interpreting findings from the interviews is the context within which outcomes were derived. Thus, just because individuals felt that their sleep had been affected by shiftwork, this did not necessarily imply that they found it to be a problem. For example, the statement "Shiftwork affects my sleep" does not necessarily translate into "Shiftwork causes problems with my sleep", the two statements are qualitatively different. This is akin to the basis of discourse analysis that argues that what people say in interviews is contingent upon the situation they find themselves in (Potter and Wetherell, 1987). The argument here is that, when responding to questions from an investigator, respondents are orienting to the particular demands of the social occasion. In view of the present study, shiftworkers may have been primed into thinking of their experiences as problematic. Such weaknesses have obvious implications for the validity of conclusions based on the interview scripts.

Finally, the way in which themes were extracted also raises a number of questions. Interview summaries were analysed for themes that were either recurrent, in the sense that they had been expressed by more than one interviewee, or, if not stated explicitly, were suggested to be strongly linked to other problem areas. Thus the extraction of themes was conducted in an informal phenomenological manner, as opposed to a more structured paradigm. By not conducting a systematic analysis of the interview scripts, observations were open to interviewer bias, with themes derived being those that supported the aims of the study. Valuable observations, outside of the specific problem domains identified in the interview plan may also have been neglected. Furthermore, because the interviews were gauged toward validating theoretical conceptions of the shiftworker's experiences, little attention was given to domains other than those that had been mentioned in the literature.

5.4.1. *Implications for Phase 2*

Although employing a semi-structured interview technique generated a wealth of valuable information, a systematic approach needs to be adopted to explore the information in a more detailed manner. Conducting a questionnaire study would allow a more in-depth study of the major problems experienced by employees at the site, the interrelationships between these problems, the variables that may affect how an individual approaches and copes with shiftwork, and the way in which it affects other aspects of day to day living. Table 5.5 highlights the themes that were used as a guide in the selection of measures to be used in the subsequent questionnaire.

Table 5.5. Measures to be included in the questionnaire

Work Situation	• Shiftwork experience • Number of hours worked per week • Job strain and job satisfaction • Perceived control of shiftwork • Perceived advantages of shiftwork
Sleep & Fatigue	• Amount and quality of sleep • Alertness • Feelings of fatigue
Health & Well-Being	• Physical health complaints • Mental health complaints (e.g. anxiety, irritability and nervousness) • General health complaints
Social & Domestic	• Amount and quality of leisure time • Value of leisure time units
Eating Behaviour & Diet	• Timing, frequency and quality of meal types • Types of meals consumed • Weight problems
Coping behaviours	• Strategies in coping with shiftwork-related problems

Whilst the list is rather comprehensive and thus lengthy, it is important to gain as much information as possible from the workers in order to assess both the problems experienced, and the impact of possible changes to the shift systems on their home and work life. A large majority of those interviewed expressed the view that the negative effects associated with shiftwork were unavoidable, and were resigned to the attitude that such problems were *"just part of the job"* and *"you just learn to put up with them"*. Consequently most approached the shiftwork-related problems they experienced with a sense of inevitability and felt guilty that their work life affected their families and friends. Such statements highlight the fact that there was definitely scope for both improvement and education amongst workers at the site.

6

PART 2: SMALL-SCALE CROSS-SECTIONAL QUESTIONNAIRE STUDY OF PRODUCTION LINE WORKERS

6.1. Introduction

The present study was the second part of an empirical assessment of the way in which shiftworkers experience their work, employing a more structured and objective approach. Conclusions from the previous chapter raised a number of important issues, such as the outcomes of shiftwork perceived as the most pertinent by workers, how problems could be specific to the type of shift worked, and the interaction of problem areas. However, it is important to underline that the first phase was intentionally conducted in a subjective, holistic manner, as a means of identifying those areas worthy of further exploration. Furthermore, conclusions were based on only a small sample of the population as a whole.

Phase 2 involved conducting a questionnaire study of shiftworkers at the computer peripherals manufacturing plant, using the findings from the semi-structured interviews, rather than formal theory taken from the literature, to guide both the design and content of the questionnaire. However, to maximise the reliability of findings and to enable comparisons with previous work in the area, standardised scales were used where possible.

In summary, the present study aimed to:

1. design a questionnaire for the collection of more structured data;
2. use this information to test and validate the findings from the interviews in terms of both the effect of shiftwork on life domains, and the interactions between outcome variables;
3. further test and explore the outcomes of shiftwork and the relationship between themes derived from the interviews using a larger sample;
4. explore the possible modifiers, and interactions between modifiers, of shiftwork outcomes.

Whilst the interviews provided a wealth of information for the selection of outcome variables that should be further explored, in contrast, identification of possible modifier variables was scant. This posed a problem since the major aim of the thesis as a whole was to investigate the effects of modifiers on both the outcomes of shiftwork and amongst themselves, in order to test and refine the existing models of shiftwork tolerance. As a remedy, the same approach was taken as the majority of models reviewed in Chapter 4, that is, the choice of modifiers was based on the literature. Consequently, modifiers employed in the present work were those that had been proposed to be most consistently and powerfully linked with shiftwork outcomes. The rationale behind each choice is discussed below. An additional aim of the thesis was to advance the knowledge in the area and so the present study adopted a very recent addition to the shiftwork literature: 'time awareness'. In doing so, a questionnaire not yet validated in shiftwork research (discussed in greater detail in the following section) was piloted.

6.2. Method

6.2.1. Questionnaire Administration

As before, individuals were informed of the questionnaire study by their line managers and supervisors and asked to complete the survey. Participation was entirely voluntary and provision was made for the survey to be completed during work time. Each production line in turn was shut down and all those wishing to participate completed the survey. No time restriction for completion was enforced. Although it was estimated, from an initial small scale pilot study during the development of the questionnaire, that the 26 page survey would take between 45 and 60 minutes to complete, the actual time taken by the sample was considerably longer at around 90 minutes (although this could be in part due to the fact that employees were given the opportunity to have time off work). Questionnaires were handed directly to the researcher upon completion.

6.2.2. Participants

Demographical details are shown in Tables 6.1a and 6.1b (overpage). Completed questionnaires were returned by 278 workers, of the initial 289 who received one, giving a response rate of 96%. Within this sample 79.9% (n=222) worked an 8h discontinuous rotating system consisting of 'Early's' (06:00-14:00) and 'Late's' (14:00-22:00), with 18.3% (n=51) working an 8h discontinuous night shift from 22:00-06:00. The remaining 1.8% (n=5) were employed on a FWO. However, due to the small sample size of the latter group, they were excluded from further analysis.

6.2.2.1. Rotating without Nights

The average number of hours worked per week was 38.91 (SD 2.89) with 6.41 (SD 2.41) as paid, and 2.96 (SD 2.55), as unpaid overtime. Of those sampled, the majority worked full time (89.6%) and were employed on a temporary contract (70.7%). Although the sample was predominantly male (indeed this was a reflection of the site as a whole) with 177 males to 45 females, age ranged widely, between 18 and 64 years ($\bar{x}$ 36.14; SD 12.62). This was reflected in the large variation in terms of work, and shiftwork experience. For example, length of work experience ranged from as little as 1 month through to 49 years ($\bar{x}$ 18.14 yrs; SD 12.83 yrs), shiftwork experience from 1 month to 38 years ($\bar{x}$ 4.88 yrs; SD 5.91 yrs), experience at the site from 1 month to 16 years ($\bar{x}$ 3.63; SD 3.60) and experience of the current shift system from 15 days to 13 years ($\bar{x}$ 2.89 yrs; SD 2.93 yrs).

Table 6.1a. Demographical details (mean, SD) by shift type

	Mean (SD)		Range	
	Rotating without nights	Permanent night	Rotating without nights	Permanent night
Age	36.14 (12.62)	35.92 (11.64)	18-64	19-59
Work experience	18.14 (12.83)	18.53 (11.87)	1mth-49yr	2.5mth-41.5yr
Experience at present site	3.63 (3.34)	3.60 (4.19)	2wks-13yr	2wks-14yr
Shiftwork experience	4.88 (5.91)	5.46 (7.43)	1mth-38yr	1mth-30yr
Present shift experience	2.89 (2.93)	1.25 (2.24)	1mth-16yr	2mth-15.25yr
Actual work hours	38.91 (2.89)	39.38 (1.47)	21-50	38-46
Hours paid overtime	6.41 (2.41)	5.82 (3.23)	1-16	1-12
Hours unpaid overtime	2.96 (2.55)	3.00 (2.65)	5-10	1-6
Locality	6.86 (6.07)	9.64 (11.72)	1-44 miles	1-55 miles

Table 6.1b. Demographical details (frequencies) by shift type

	Frequency		%	
	Rotating without nights	Permanent night	Rotating without nights	Permanent night
Gender:				
Male	177	37	79.7	72.5
Female	45	14	20.3	27.5
Contract:				
Temporary	157	37	70.7	72.5
Permanent	64	14	28.8	27.5
Full Time	199	49	89.6	96.1
Part Time	10	2	4.5	3.9
Marital Status:				
Married/living with partner	112	22	50.5	43.1
Single	82	5	36.9	45.1
Separated/divorced	26	23	11.7	9.8
Dependants:				
0	82	20	36.9	39.2
1	19	7	8.6	13.7
2	45	6	20.3	11.8
3	13	5	5.9	9.8
4	3	1	1.4	2.0
5	2	1	0.9	2.0

Of those sampled, 50.5% were married or living with a partner, 36.9% were single and 11.7% separated or divorced. 140 had no children, whilst the remaining 82 had at least one child ($\bar{x}$ 2.07; SD 0.87; range 1-5). In terms of locality, the majority of workers (89%) lived locally, that is to say within 10 miles of the site ($\bar{x}$ 6.86 miles; SD 6.07; range 1-44).

6.2.2.2. Permanent Nights

The average number of hours worked per week was 39.38 (SD 1.47) with 5.82 (SD 3.23) as paid, and 3.00 (SD 2.65), as unpaid overtime. Of those sampled, the majority worked full time (96.1%) and were employed on a temporary contract (72.5%).

Again the sample was predominantly male (37 males to 14 females) and had a wide dispersion of ages with a range from 19-59 and a mean of 35.92 (SD 11.64). As with the rotating shift workers, those on the night shift showed a large variation of work, and shiftwork experience. Length of work experience ranged from as little as 2.5 months through to 41.5 years ($\bar{x}$ 18.53 yrs; SD 11.87 yrs) whilst shiftwork experience ranged from 1 month to 30 years ($\bar{x}$ 5.46 yrs; SD 7.43 yrs). Experience at the site ranged from 2 months to 15.25 years ($\bar{x}$ 3.34; SD 4.19) whilst experience of the current shift system also showed a wide range from 15 days to 14 years ($\bar{x}$ 1.25 yrs; SD 2.24 yrs).

Of those sampled, 43.1% were married or living with a partner, 45.1% were single and 9.8% separated or divorced. 31 had no children, whilst the remaining 20 had at least one child ($\bar{x}$ 2.15; SD 1.14 range 1-5). In terms of locality, the majority of workers (82.4%) lived locally ($\bar{x}$ 9.64 miles; SD 11.72; range 1-55).

6.2.2.3. Comparison of Groups

Comparisons between groups on the demographic variables showed that the samples significantly differed on the length of 'current shift pattern experience' ($t_{(266)}$=4.346, p<.001), where those working rotating shifts without nights had over twice the length of experience of those working permanent nights, and the 'number of hours contracted to work each week' ($t_{(263)}$=2.455, p<.05), with nightworkers contracted to work more hours. Chi-square analysis revealed a significant association between shift type and gender (χ^2=1.26, p>.05), contract (χ^2=.46, p>.05), full-time versus part-time (χ^2=.69, p>.05) and number of dependants (χ^2=4.067, p>.05).

6.2.3. Materials

The structure of the survey (see Appendix 4) was largely based around the Standard Shiftwork Index (SSI; Barton, Spelten, Totterdell, Smith, Folkard and Costa, 1995) and the Survey of

Shiftworkers (SOS; Folkard, Smith, Macdonald and Tucker, 1997), since both contained standardised measures designed to address the variables specified throughout the interviews. However, where neither included scales for certain areas, such as 'eating behaviour and diet', new scales were constructed. The following section describes each of the scales employed in the present survey.

The psychometric properties of each are also discussed (see Table 6.2, Appendix 5). Where standard scales were employed, an attempt was made to replicate the suggested factor structures. For newly constructed scales, the results of factor analysis are reported. All factor analysis was based on Principal Components Analysis using Varimax rotation. Furthermore, only items with a factor loading of > 0.30 were considered for inclusion, and where an item loaded on more than one factor, the highest loading was used for classification. However, due to the small number of participants in the present sample, further analysis was based on the original scoring methods, *on all scales*, to allow comparison with previous research.

6.2.3.1. Modifier Variables

Demographic

Variables included in this category included many of those discussed within the context of the 'Participants' section above. In brief these were age, gender, marital status, number of dependants, work area, contract type, tenure type, hours contracted to work each week, hours actually worked each week, hours paid and unpaid overtime worked each week, years of work experience, years of shift experience, years at present site, years in present shift system, locality and commuting time. Also included, but not yet discussed, were questions relating to partners' work hours, work pattern and their feelings about the individual working shifts. Nominal variables with more than one category were recoded into dichotomous measures for analysis. Thus, for example, marital status, that contained the categories (1) married/with partner, (2) single, (3) separated/divorced and (4) widowed, was recoded into 'with partner' and 'without partner'.

Circadian

Composite Morningness Questionnaire (CMS)

Evidence from research into human circadian rhythms has shown there to be two diurnal types of person, M-types or 'larks' and E-types or 'owls'. These two extreme types show the highest physiological and behavioural variables at different times of day, and are especially pronounced in terms of their sleeping and waking habits. The importance of this dichotomy in shiftwork research lies in the assumption that if the daily schedule of activity does not correspond to an individual's diurnal type, then psychological and physiological disturbances may arise. In terms of shiftwork it has been argued that M-types are better suited to daywork or work involving the earlier part of the day, whilst E-types may be better able to tolerate shiftwork, especially that involving nights.

The CMS (Smith *et al.*, 1989) is a 13-item measure based upon existing published morningness questionnaires, with 9 items selected from Horne *et al.* (1976) and 4 items selected from Torsvall & Åkerstedt (1980). Individual items were scored on a 1-4 or 1-5 scale, depending on the number of response options given, with the direction of scoring varying across items. Scores were then summed to give an overall value.

Circadian Type Inventory (CTI)

Evidence from previous research has shown that shiftworkers who are rigid in their sleeping habits or languid in their ability to overcome drowsiness, can experience high levels of manifest anxiety. Strong positive correlations have also been found between flexibility and vigouressness and tolerance to shiftwork involving night duty. Based on the Circadian Type Questionnaire (Folkard *et al.* 1979; Kaliterna *et al.* 1988; Costa *et al*, 1989) the CTI measures two subscales relating to the flexibility of sleeping habits (flexibility/rigidity) and the ability to overcome drowsiness (languidity/vigorousness). Originally a 30 item scale, more recent analysis has resulted in the reduced 18 item version employed here.

Respondents were asked to rate their daily habits and preferences in terms of the things they preferred to do, or were able to do, in relation to their present shift system. Items were scored on a 5 point Likert scale with response options ranging from 'Almost never' to 'Almost always'. On both the first factor, 'Languidness/Vigorousness', and the second factor, 'Flexibility/Rigidity', a high summed score indicated a tendency towards the first of the two labels.

Time Awareness Questionnaire (TAQ)

Based on an unpublished scale by Folkard (1998), the TAQ is an additional 38-item measure of circadian rhythmicity divided into 3 subscales: (1) Early/Late Preferences (Smith *et al.*, 1989): 14 items relating to an individual's preference as to the time of day that certain activities are performed; (2) Strength of Early/Late Preferences: 14 items on the strength of an individual's preference as to the time of day that various activities are performed; (3) Time Awareness: 10 items relating to the ability to track the time of day without reference to a clock or watch. Together they allow analysis of an individual's rhythmicity, the strength of this rhythmicity and hence their ability to adjust their rhythm according to different types of shift system. Participants were asked to rate their responses in comparison to those of most people. 5 text response options (with a value of 1 through to 5) were provided for each item, e.g. 'Much earlier', 'A little earlier ', 'About the same', 'A little later' and 'Much later'. A total score for each subscale was then obtained by summing the value of the response options for each of the component items.

Analysis of the first large-scale trial of the scale (as part of the present thesis) resulted in a reduced 29 item version, as detailed below, although the 3 factor structure was maintained. Since this analysis included data from the present sample, separate factor analysis was not performed. In order to score the TAQ, responses from the three survey studies detailed in the thesis were collated, giving a total of 541 participants (M:F ratio 477:61; $\bar{x}$ age, 39.18: SD 11.66; range 18-65). Principal Components Analysis specifying a 3 factor solution extracted 3 factors with eigenvalues greater than 1 that, between them accounted for 34.31% of the total variance. Varimax rotation of these components converged in 5 iterations and yielded the factor loadings (with absolute values of <.4 suppressed) displayed in Table 6.3.

Of the 38 items included on the TAQ, only 29 were represented in the factor loadings. Of those excluded, 4 related to the original Early/Late Preferences subscale (items 4, 9, 14 and 26) and included preferred times for socialising, eating and bed times, 3 to the Time Awareness subscale (items 2, 6 and 24) which related to the ability to predict the time by how awake respondents feel, to return to a job punctually after taking a half hour break and being shocked at learning what the time is, and 2 to the Strength of Preferences subscale (items 5 and 8) which related to a person's strength of preference as to what time they would get up if they had a day off and nothing to do, and what time they would get up if they had a full day's work to do.

Of the remaining items, Factor 1 accounted for 13.24% of the total variance, with loadings ranging from +0.780 to +0.487, and comprised 10 items, all of which related to an individual's preference as to the time of day that certain activities are performed. Since such measures are typically used to classify individuals along the M-E-type dichotomy, this first factor was named 'Morningness/Eveningness'. Factor 2, comprising 7 items relating to the ability to track the time of day without reference to a clock or watch, accounted for 10.73% of the total variance and contained loadings ranging from +0.783 to +0.477. This was named 'Time Awareness'. Factor 3 accounted for 10.34% of the total variance and comprised the highest number of items (with a total of 12) but the lowest range of loadings (+0.653-+0.425). Here all items related to the strength of an individual's preference as to the time of day that certain activities are performed, and thus retained the term 'Strength of Early/Late Preferences'.

Table 6.3. Rotated Factor Loadings of the 38-item TAQ

Item	Factor 1	Factor 2	Factor 3
1	**+0.487**		
2			
3			**+0.484**
4			
5			
6			
7	**+0.532**		
8			
9			
10			**+0.507**
11	**+0.653**		
12		**+0.477**	
13	**+0.572**		
14			
15			**+0.552**
16			**+0.629**
17		**+0.695**	
18	**+0.728**		
19			**+0.496**
20			**+0.482**
21	**+0.775**		
22		**+0.718**	
23			**+0.653**
24			
25	**+0.678**		
26			
27	**+0.742**		
28		**+0.618**	
29			**+0.502**
30		**+0.741**	
31			**+0.518**
32			**+0.425**
33		**+0.783**	
34	**+0.780**		
35			**+0.567**
36			**+0.584**
37		**+0.657**	
38	**+0.630**		

In order to test the reliability of the items within the 3 factors, Cronbach alphas (excluding the item) were calculated. As can be seen in Table 6.4, the results indicated that for Morningness/Eveningness, item 1 ("when would you prefer to get up if you had a day off and nothing to do?"), with the lowest factor loading, increased the alpha coefficient of the total from .8700 to .8707. Since this was not a considerable increase, the item was retained. Likewise, for Time Awareness, item 12 ("if you wake up in the middle of the night do you know how many hours sleep you have had?"), again with the lowest factor loading, increased the alpha coefficient of the total from .8221 to .8235 but was not excluded. No item within Factor 3: Strength of Early/Late Preferences reduced the total scale alpha. The factor loadings, inter-item correlations and alpha coefficients of the reduced 29 item version of the TAQ are shown in Table 6.5 (Appendix 6).

Table 6.4. Cronbach alpha coefficients for each factor of the 29-item TAQ

Morningness/Eveningness		Time Awareness		Strength of Preferences	
Item	α (exc. the item)	Item	α (exc. the item)	Item	α (exc. the item)
1	.8707	12	.8235	3	.7865
7	.8664	28	.8096	32	.7829
13	.8634	37	.8039	29	.7791
38	.8602	17	.8001	15	.7790
11	.8561	22	.7910	20	.7777
25	.8560	33	.7788	31	.7776
27	.8522	30	.7784	19	.7772
34	.8498			10	.7765
18	.8495			35	.7764
21	.8493			16	.7721
				36	.7697
				23	.7663
Total α	**.87**	**Total α**	**.82**	**Total α**	**.79**

From these findings the scoring of the TAQ was based on the reduced 29 item version of the measure (see Appendix 2). Scores on each of the factors were derived from the summed scores for each of the items included in that factor. With a possible range from 9-45, a high score on "Morningness/Eveningness" indicated a tendency toward the latter of the two labels, whilst a high score on the "Strength of Early/Late Preferences" (range 12-60) and "Time Awareness" (range 6-30) indicated a tendency toward weak preferences and poor time awareness respectively. In order to make the scales more intuitive, all were reversed, such that high scores were indicative of morningness, strong preferences and good time awareness.

Type of Sleeper (Long vs. Short)

Taken from the SSI, this consisted of a single item asking the respondent the number of hours sleep they felt they needed per day, irrespective of their work pattern. Here a high score indicated a high sleep need. Although actual sleep duration during work days was considered for this purpose it was felt that it would be influenced by the type of shift worked, and therefore not necessarily reflect the *preferred* sleep length.

Personality

Eysenck Personality Inventory (EPI-12)

The 12 item version of the EPI is divided into two 6-item subscales in order to measure the two major personality dimensions of extraversion and neuroticism. This scale follows on from the CMS, in that previous research has demonstrated a relationship between the personality factors of introversion and morningness, and between extraversion and eveningness (Blake, 1967). Further work has shown that extroverts compared to introverts experience fewer health problems associated with working shifts, and therefore suggests that extroverts are typical E-types (Singer and Levens, 1990).

Items were scored according to the method used in the SSI, i.e., on a 4 point Likert scale with response options ranging from '1=Almost never' to '4=Almost always'. The two subscales are scored separately. A high score on each subscale indicated a tendency toward extroversion and neuroticism respectively.

Coping Strategies Questionnaire (CSQ)

Based on the Coping Strategies Inventory of Tobin, Holroyd & Reynolds (1984), the CSQ employs an approach/avoidance dichotomy, the former corresponding to an enhancement of the aversive aspects of the situation, and the latter to a blunting of the situation. This in turn can be used to distinguish between engagement and disengagement strategies. Developed specifically for the SSI, the original CSQ comprised 32 items covering 8 basic coping strategies. The respondent is asked to indicate the extent to which they utilise the 8 strategies with regard to 4 problem areas typically associated with working shifts, i.e., sleep, social life, domestic life and work.

The CSQ appeared in a shortened format in the present questionnaire in light of the overall length. Instead of using a separate question for each of the 4 problem areas respondents were asked to rate the extent to which they used each of the coping strategies listed in relation to *any* problems caused by working shifts. Items were scored on a 5 point Likert scale with response options ranging from '1=Not used a great deal' to '5=Used a great deal'. Higher scores were associated with higher levels of engagement or disengagement.

Shiftwork Locus of Control Scale (SHLOC)

Developed by Smith *et al.* (1995) in response to their dissatisfaction with previous scales aimed at work behaviour, the SHLOC is a 20 item shiftwork-specific measure with items relating to a variety of shiftwork related domains including sleep, social life, health and work. In an attempt to minimise the length of the present questionnaire, a shorter 8 item version was employed, using only the top two items with the highest factor loadings within each subscale, as reported in Smith *et al.* (1995).

Respondents were asked to rate the extent to which they agreed or disagreed with the statements presented. Items were scored on a 6 point Likert scale with response options ranging from '1=Strongly Disagree' to '6=Strongly Agree'. An overall score was obtained by summing the value of the response options across the 8 items. Higher scores denoted a more internal orientation.

Value of Leisure Time Units (VLTU)

This scale was specifically developed for use within the present study with the intention of assessing the way in which respondents subjectively valued different times of day in terms of the things they liked to, or had to do, outside of work. The practical applications of such data for occupational settings lies in the design of alternative shift systems which decrease the amount of time that employees will have to work during the hours they value the most (Wedderburn, 1981).

The VLTU scale comprised a table with 8 time slots divided into 3 hourly intervals, beginning at 12am-3am and ending at 9pm-12am. Using the response options 1="Extremely valuable" to 9="Extremely useless", respondents were required to rate how valuable certain times of the day were to them. The VLTU across the whole week, between days of the week and of certain times of the day were obtained by summing the value of the response options across the appropriate day and time slot. Since the arrangement of response options would result in high values being associated with the most useless times, the scale was reversed so that a high score was associated with the times that were more highly valued. A 'preference for weekends over weekdays' measure was derived by dividing the mean of responses given for all time slots during the weekdays by the mean of responses for weekends. A similar procedure was conducted in order to derive a 'preference for mornings over evenings'. A high score indicated a preference for weekends and/or evenings.

Work

Workload

In order to measure workload, respondents were asked to rate their physical workload, mental workload, time pressures and emotional stress, for each of the shifts worked, in comparison to the average workload of other people performing a similar job in other parts of the site. Appearing in the same form as in the SSI, responses were scored on a 5 point Likert scale from '1=Extremely Light' to '5=Extremely Heavy'. Overall workload was derived by summing the responses for each of the 4 subscales, with a high score denoting a heavy workload.

Job Strain

Job Strain was assessed according to the Demands/Discretion model proposed by Karasek (1979). This model defines job strain as jobs characterised by "high psychological work demands" combined with "low decision latitude". A 12-item questionnaire adapted from Knuttson and Nilsson (1997) was employed, from which 3 dimensions could be derived: (1) Job Demand: 5 items regarding the pacing and amount of work; (2) Decision Latitude: 4 items regarding control over the job, incorporating both skill utilisation and decision authority; (3)

Job Freedom: 3 items regarding freedom within the job. Respondents were asked to rate the extent to which they experienced each of the statements. The items were scored on a 4 point Likert scale with response options ranging from '1=Often' to '4=Never/Almost Never'. A high score represented a high level of perceived job demands and/or a high level of perceived decision latitude and/or a high level of perceived freedom on the job.

Control

Since control was not explicit in either the model or questionnaire proposed by Karasek, items specific to control in shiftworking situations were used. Control over the job was assessed by a single question where respondents were asked to rate the extent to which they perceived the pacing of their job to be under their control. Used in the same form as it appeared in the SSI, response options ranged along a 5 point Likert scale from "1=Entirely outside of my control" to "5=Entirely under my control". Control over the work pattern was assessed by a 2 item measure asking the respondent to rate the extent to which they felt they had control over (1) the specific shifts worked; and (2) the start and finish times of the shifts worked. Response options ranged from 1= "None" through to 5="Complete".

General Job Satisfaction

Job Satisfaction was assessed in a 5-item questionnaire measuring the degree to which the employee was "satisfied and happy with the job". This scale forms part of the larger Job Diagnostic Survey (Hackman and Oldham, 1975) and appeared as it did, in revised form, in the SSI. Items were scored on a 7 point Likert scale with response options ranging from '1=Disagree Strongly' to '7=Agree Strongly', with items B and E being reverse coded. General Job Satisfaction was calculated as the mean value of the 5 items, where a high score was associated with a high degree of satisfaction and contentment with the job.

6.2.3.2. Outcome Variables

Sleep

The questionnaire here used the sleep scale designed especially for the SSI. Divided into 2 sections, the first measured the sleep habits adopted by workers and whether these changed as a function of the shift worked. Respondents were asked to report the times at which they fell asleep and woke up before their first early, late, and night shift, between two successive, and after their last, shift. Respondents were also asked to include the same information in relation to their days off. This first section also included a question relating to the frequency and timing of naps taken outside of the normal sleep times. Actual sleep times were used to compute the mean sleep duration, onset and offset times between different shifts and between shift changes.

The second section was an 8 item measure relating to the quality of sleep and the extent to which sleep disturbance was dependent upon the type of shift worked. Scored on a 5 point Likert scale with different descriptors for each question, e.g. '1=Definitely not rested' to '5=Extremely rested', responses were summed to give a total sleep disturbance score, with higher scores indicating more disturbance. Items relating to alcohol and sleeping pill consumption were also included but coded independently and did not form part of the scale.

Alertness

A 3 item questionnaire aimed at measuring subjective feelings of alertness at 2 hourly intervals before, during and after an average early, late and night shift was employed. This was used in the same form as it appeared in the SSI. Times ran from 04:00 through to 02:00 for early, 06:00 through to 04:00 for the late, and 12:00 through to 10:00 for the night shift. Respondents were required to rate their feelings of alertness for each of the shifts worked. Scored on a 9 point Likert scale with response options ranging from '1=Very alert' to '9=Very sleepy (fighting sleep)', alertness for each shift type was obtained by summing the value of responses, with a higher score being associated with greater feelings of tiredness.

Health and Well-Being

Chronic Fatigue

Chronic Fatigue, defined as "a general tiredness and lack of energy irrespective of whether an individual has had enough sleep or has been working hard, which persists even on rest days and holidays", was assessed with the brief mental fatigue questionnaire (Bentall, Wood, Marrinan, Deans, and Edwards, 1993). Containing 9 items relating to mental fatigue symptoms, respondents were asked to rate the extent to which they had been bothered by the symptoms during the past month. Items were scored on a 5 point Likert scale with response options ranging from '1=Not at all' to '5=Very Much'. Chronic Fatigue was calculated as the sum value of the 9 items, with a high score being associated with a high level of fatigue. However, since this particular chronic fatigue scale had not yet been tested on a shiftworker population, the 3 items relating to fatigue included in the SOS were also incorporated. Relating primarily to physical fatigue, the 3 item scale was scored in the same way.

Physical Health Questionnaire

In order to assess the major physical health problems associated with shiftwork, the Physical Health Questionnaire, specifically constructed for the SSI, was employed. Divided into 3 sections, the first was designed to measure the incidence of digestive (8 items) and cardiovascular complaints (9 items). In its original form in the SSI, the measure contained two additional questions regarding weight change since beginning shiftwork. However, since the survey used here contained a section specifically dedicated to eating behaviour and diet, where weight change was addressed, the final two items were dropped. In their place, two additional questions, taken from the SOS, were added, the first relating to minor infections, such as colds and flu, and the second relating to musculoskeletal pain. Respondents were asked to rate how frequently they experienced the symptoms on a 4 point Likert scale (in an attempt to avoid a tendency towards a central answer), with response options ranging from '1=Almost Never' to '4=Almost Always'. A total score for each scale was obtained by summing the total value of the response options corresponding to that scale. A higher score denoted poorer physical health.

Section 2 comprised a 23 item health audit in the form of a checklist of illnesses and medical conditions, which it has been suggested, may be exacerbated by working shifts. Respondents were asked to check the medical conditions that had been diagnosed by their doctor, before and since starting shiftwork. These items were treated independently and did not form part of the overall questionnaire.

Section 3 contained 3 general questions related to health behaviours covering smoking habits, alcohol consumption and caffeine consumption. Respondents were asked to give absolute amounts of cigarettes, alcohol and caffeine consumption before and since starting shiftwork and on work days compared to rest days.

General Health Questionnaire (GHQ-12)

A 12 item version of the General Health Questionnaire (Goldberg, 1972), the GHQ-12 is a self-administered screening test for detecting minor psychiatric disorders such as recent levels of self-confidence, depression, sleep loss, and problem solving. Designed for use in the general population, it gives a single measure of mental health over the previous few weeks. Respondents were asked to rate how they had felt in general, using the 4 text response options provided for each item, e.g. 'Better than usual', 'Same as usual', 'Less than usual' and 'Much less than usual'. A total score was produced by summing the value of the response options (ranging from 1-4) for each of the 12 items, with a higher score indicating poorer psychological health.

Cognitive-Somatic Anxiety Questionnaire (CSAQ)

The CSAQ (Schwartz, Davidson and Goleman, 1978) was a 14 item measure of trait anxiety used to assess separately the somatic and cognitive components of the state. The questionnaire consisted of 14 descriptions of symptoms of anxiety: 7 of a cognitive orientation (e.g., "I can't keep anxiety provoking pictures out of my mind") and 7 of a somatic orientation (e.g., "My heart beats faster"). The CSAQ appeared as it did in the SSI where item (l) which in the CSAQ read 'I become immobilised', was modified to read 'I feel physically immobilised'. This was due to ambiguous wording in that it was possible to interpret the word 'immobilised' in both a physical and mental sense.

Respondents were asked to indicate the degree to which they generally or typically experienced each of the symptoms when they were feeling anxious. Items were scored on a 5 point Likert scale with response options ranging from '1=Not at all' to '5=Very much so', with the two subscales scored separately. A total score for each was obtained by summing the value of the response options for items on each scale, with higher scores denoting more cognitive and/or somatic anxiety.

Social and Domestic Satisfaction

Social and Domestic Survey

Satisfaction with the amount of time the shift system left the worker for various social (e.g. sports, hobbies) and domestic (e.g. childcare, shopping) activities was assessed using the Social and Domestic Survey as it appeared in the SSI. Divided into 2 sections, the first comprised a 19 item measure with questions relating to the amount of time the shift pattern left for various activities outside the commitments of work. Section 2 comprised 3 general questions relating to satisfaction with social and domestic life. Items for both sections were scored on a 5 point Likert scale with response options ranging from '1=Not at all' to '5=Very much'. For section 1, a total score for general satisfaction was obtained by summing the value of the responses for all 19 items. For section 2 items were scored separately to give a valuation of the amount of time for each type of activity. For the first section a higher score was associated with a greater level of social and domestic satisfaction, whilst in the second, a higher score was associated with more disruption. For this reason, the first scale was reversed such that a high score indicated less satisfaction.

Eating Behaviour and Diet

The common association between shiftwork and gastrointestinal disorders may be mediated by many factors, the most obvious being the eating habits of shiftworkers, since it may be assumed that an irregular lifestyle might affect eating behaviour and diet (Armstrong, 1980; Adams and Morgan, 1981; Tepas, 1990; Verboeket-van de Venne and Westerterp, 1990). It is well documented in the literature that the amount, composition, and distribution of food intake may affect health in general and thus is a prime area for education and recommendations for change.

Since neither the SSI nor the SOS contained scales relevant to an assessment of the eating behaviour and diet of shiftworkers, and how they might be affected by other variables covered within the present questionnaire, a scale was specifically designed for this purpose. Items selected for inclusion were taken from comments made during the interview stage and covered areas such as the timing and frequency of different types of meals, the types of meals consumed, use of the on site canteen, and exacerbation of weight problems.

Section 1 related to the frequency of different meal types (breakfast, lunch, and dinner) according to the shift systems worked. Items were scored on a 5 point Likert scale with response options ranging from '1=Never' to '5=Always', where a higher score denoted a higher frequency of meals. Section 2 related to the frequency of snacking during different shift types and on days off. Items were scored on a 5 point Likert scale with response options ranging from '1=Never' to '5=Always', with a high score indicating more snacking. Section 3 related to the regularity of eating patterns in terms of the timing of meals. Items were scored on a 5 point Likert scale with response options ranging from '1=Very regular' to '5=Very irregular', with a high score denoting irregularity. Section 4 asked the respondent to give absolute values as to the number of cooked main meals consumed within the past week on different shifts. Section 5 was concerned with the source of different meal types, i.e., whether meals were bought from the canteen, eaten at home, prepared and brought in from home, or bought from the vending machines. Section 6 asked the respondent to indicate whether they ate a balanced and nutritious diet on different shift types and on days off. Items were scored on a 5 point Likert scale with response options ranging from 'Never' to 'Always'. A high score denoting a more nutritious meal. Finally, Section 7 related to weight change since beginning shiftwork. The response was scored on a 5 point Likert scale with options ranging from 1='Put on alot' to 5='Lost alot'.

Attitudes toward Shiftwork

Shiftwork Advantages

In contrast to the negative bias within shiftwork research there is evidence that some people enjoy working shifts (Harrington, 1978; Wedderburn, 1981; Olsson *et al.*, 1990). In order to assess the perceived advantages of shiftwork, the 17-item measure of shiftwork advantages, as derived by Taylor *et al.* (1997) was used as it appeared in the SSI. Comprising 4 subscales corresponding to the areas typically documented in shiftwork research, i.e. family, social/domestic, work and time for oneself, respondents were asked to rate whether each item was an advantage for them. Items were scored on a 5 point Likert scale with response options ranging from '1=Definitely not' to '5=Probably yes'.

Respondents' attitudes were also assessed through a further 3 measures. The first was a single item asking whether the advantages of shiftwork outweighed the disadvantages. The second was a single item asking "all things being equal, would you prefer daywork to shiftwork". Both were scored on a 5 item response scale with options ranging from '1=Definitely not' to

'5=Definitely yes'. Finally, respondents were given the opportunity to report the 3 main advantages and 3 main disadvantages of their shift system in the text boxes provided.

Perceived Problems

In an extension of the measure employed in the SSI, respondents were asked to rate the extent to which working shifts caused problems in the 6 key areas covered within the theoretical model of shiftwork mentioned earlier. These were (1) work performance, (2) sleep, (3) social life, (4) domestic life, (5) health and well-being, and (6) eating behaviour and diet, the latter two of which were added specifically, due to the fact they were identified as key areas in the interview stage, and that the survey contained sections dedicated to them already. Items were scored on a 5 point Likert scale with response options ranging from '1=Never' to '5=Always'. As well as being scored independently, the mean of all 6 items was also derived in order to give an overall score of the extent of shiftwork related problems for each respondent. Analysis indicated that all 7 items loaded highly on a single factor (accounting for 54.4% of the total variance) with a total alpha coefficient of .83.

6.3. Results

6.3.1. Statistical Analysis

In the first instance, scores derived from the outcome measures were analysed by shift type, in order to assess their relative impact. Multivariate analysis in the form of regressions were then performed to investigate the predictive power of modifiers with the influence of covariates both uncontrolled and controlled. However, due to the large number of variables derived from the questionnaires, both outcome and modifier variables were firstly subjected to factor analysis or Pearson's correlations. The following sections discuss the rationale behind doing so and the findings that resulted.

6.3.1.1. Reduction of Outcome Variables

All outcome variables were submitted to exploratory factor analysis in an attempt to reduce their total number. Where scales had been derived from items such as social and domestic disruption, the scales, rather than the individual component items, were used. From the 39 variables entered, Principal Components Analysis with Varimax rotation extracted 9 factors with eigenvalues greater than 1, which between them accounted for 69.47% of the total variance.

With loadings ranging from .317 to .739, Factor 1 accounted for 14.69% of the variance, and contained the highest number of items, 11 in total, all of which related to psychological health (GHQ-12 scores, cognitive and somatic anxiety, neuroticism, and disengagement), and sleep problems (sleep disturbance, cognitive and physical fatigue, and alertness). However, the perception of problems with work performance and health and well-being were also included. When subjected to Cronbach alpha excluding the item, exclusion of on-shift sleepiness and perceived problems with work performance were found to increase the total scale reliability of .8293 to, in the former case, .8526, and in the latter to .8305. Since neither of these resulted in a substantial increase both were retained, and the factor named 'Psychological Health and Sleep Disturbance'. Thus, despite debate in the literature as to whether neuroticism should be employed as an outcome or modifier of shiftwork tolerance, the high factor loading here in combination with other measures of psychological health was deemed strong enough to treat it as an outcome variable in further analysis.

Factor 2 contained 6 items relating to social and domestic disruption, with factor loadings ranging from .548 to .767. Both the 3-item measure of the extent to which shiftwork interfered with leisure, domestic and non-domestic time and the first section of the social and domestic disruption scale were included, as were the perception of social and domestic problems, yielding a factor which accounted for 10.24% of the total variance. Reliability analysis resulted in a total scale alpha of .3485, which after exclusion of the first section of the social and domestic survey increased to a respectable .7932. Thus, the 5 item factor structure was retained and named 'Social and Domestic Disruption'.

Factor 3, accounting for 9.50% of the variance, contained 6 items relating to the perceived advantages of shiftwork – which included the 4 subscales of the advantages of shiftwork questionnaire along with the single items "Do you feel that the advantages of your shift system outweigh the disadvantages?" and "All things being equal, would you prefer to give up working shifts and get a day job without shifts?". Apart from the final item, all loaded positively. Cronbach alpha yielded a score of .6732, which after exclusion of 'a preference for daywork' showed a considerable increase to .7960. Thus the 5 item factor structure was used in further analysis and named 'Perceived Advantages of Shiftwork'. 'A preference for daywork' was treated independently in further analysis.

Factor 4, accounting for 7.69% of the variance, contained the 4 subscales of the Physical Health Questionnaire where loadings ranged from .466 (minor infections) to .808 (musculoskeletal pain). However, it was also noted that cognitive fatigue, cognitive and somatic anxiety and perceived problems with health & well-being and eating behaviour & diet also loaded relatively highly. Reliability analysis yielded a total scale alpha of .6629. Although exclusion of the item on minor infections would have increased this figure to .7007, the improvement was not substantial and the item retained.

Factor 5 contained 3 items, 'weight change since beginning shiftwork' (loading of -.753), 'perceived problems with sleep' (loading of .453), and 'perceived problems with eating behaviour and diet' (loading of .419). Accounting for 6.68% of the total variance, the factor achieved an unacceptable scale alpha of .1797, with the exclusion of all items resulting in an increase. Therefore, based on these findings no further analysis was performed with this factor.

With loadings ranging from .792 to -.501, Factor 6 accounted for 6.34% of the variance and contained 4 items relating to dietary behaviour, e.g. timing of meals, frequency of breakfast and lunch, and whether meals were perceived as being balanced and nutritious. Cronbach alpha on the 4 item solution was poor at .4219, although excluding the timing of meals yielded a substantial increase to .7003. Interestingly, the frequency of dinner loaded on a separate factor with snacking, although this reached poor reliability at just .2744. Since it failed to result in an acceptable combination (loading of .502) with snacking, and given that it had a loading of .440 on Factor 6, where intuitively one would have expected it to appear alongside the frequency of breakfast and lunch, reliability analysis with this item included was repeated. This resulted in an increased total scale alpha from .6530 to .7013. Thus factor 6, named 'Dietary Behaviour' contained the frequency of breakfast, lunch and dinner, and the perception of a balanced and nutritious diet.

Factors 7, 8, and 9 contained only one item each – the use of sleeping pills (loading of .699) accounting for 3.60%, the number of cooked main meals consumed per week (loading of -.860) accounting for 3.50%, and the use of alcohol as a sleeping aid (loading of .809) accounting for 3.24%, respectively. Reliability analysis could not be performed and the items were not included in further analysis. Furthermore, inspection of the data showed a substantial proportion of missing data on these three items, an additional reason to omit them from analysis. This was also the case for medical conditions (section 2 of the physical health questionnaire).

The strength of interactions amongst outcome variables was further explored by correlating the five factors against one another. The results are summarised in Table 6.6. From this it is evident that the strongest association was between the two health outcome measures ($r_{(268)}$=.610, p<.001), with the direction of the association suggesting that a shiftworker who reported greater psychological health and sleep problems also tended to report greater physical health symptoms. Psychological health and sleep was also significantly correlated with the three remaining factors, with the strength of the relationships being in the order: social/domestic life ($r_{(270)}$=.359, p<.001), advantages of shiftwork ($r_{(269)}$=-.300, p<.001) and eating behaviour and diet ($r_{(270)}$=-.231, p<.001) in addition to the length of sleep before the first early ($r_{(218)}$=-.273, p<.001) and late shifts ($r_{(207)}$=-.178, p<.01) of the cycle and between successive late shifts ($r_{(201)}$=-.142,

$p<.05$). Thus a participant who reported having greater psychological health and sleep problems also tended to suffer social and domestic disruption, to perceive shiftwork as offering fewer advantages, have poorer dietary habits, and less sleep at certain points of the shift cycle.

Social and domestic disruption was also significantly correlated with all factors, with the strength of relationships being in the order: perceived advantages of shiftwork ($r_{(269)}=-.541$, $p<.001$), psychological health and sleep ($r_{(270)}=.359$, $p<.001$), physical health ($r_{(268)}=.205$, $p<.001$) and eating behaviour and diet ($r_{(270)}=-.145$, $p<.05$). The interaction between social/domestic disruption and perceived advantages of shiftwork was perhaps indicative of the fact that 2 of the 4 subscales within the advantages measure related directly to social and family activities. However, its relationship with the second attitude item, a preference for daywork over shifts, suggested an independent link. Interestingly, whilst psychological health and sleep was related to sleep lengths for rotating workers, for sleep length between successive night shifts only social and domestic disruption achieved significance ($r_{(42)}=.307$, $p<.05$).

Perceived advantages of shiftwork were found to correlate with all outcome variables except physical health. As discussed above, the strongest correlation was with social and domestic disruption, followed by psychological health and sleep and dietary behaviour ($r_{(269)}=.127$, $p<.05$). Perceived advantages were also related, albeit weakly, to the length of sleep before the first early and late shifts, and between successive early shifts. The pattern of findings suggested that workers who perceived shiftwork as having a number of advantages also reported less social and domestic disruption, better psychological health and sleep, better dietary habits and greater sleep. In comparison the factor labelled dietary behaviour correlated with all outcomes except physical health. Here the strongest association was with psychological health and sleep ($r_{(270)}=-231$, $p<.001$), followed by social and domestic disruption ($r_{(270)}=-.145$, $p<.05$) and perceived advantages of shiftwork ($r_{(206)}=.127$, $p<.05$). Only one significant association was evident with sleep length, being weakly positively correlated with sleep before the first early shift of the cycle ($r_{(218)}=.191$, $p<.01$).

The relationships between sleep length after the last early shift and before the first late shift were not surprising given that, for rotating workers, both measures cover the same period between shifts. However, interestingly the amount of sleep gained following a run of early shifts was also related to sleep gained between and after the run of late shifts. This was also the case for sleep between rest days, which was found to be positively related to the aforementioned variables only.

Table 6.6. Correlations between outcome variables amongst production line workers

	Psych.	*Social*	*Adv.*	*Pref.*	*Physical*	*Diet*	*Sleep length*								
							Before 1^{st} E	Between E	After last E	Before 1^{st} L	Between L	After last L	Before 1^{st} N	Between N	After last N
Psychological	-														
Social	**.359 *****	-													
Advantages	**-.300 *****	**-.541 *****	-												
Preference	**.232 *****	**.417 *****	**-.593 *****	-											
Physical	**.610 *****	**.205 *****	-.091	**.121 ***	-										
Diet	**-.231 *****	**-.145 ***	**.127 ***	-.063	-.085	-									
Sleep Length															
Before 1^{st} E	**-.273 *****	-.017	**.149 ***	-.043	.021	**.191 ****	-								
Between E	-.129	-.068	**.179 ****	-.069	-.008	.051	**.433 *****	-							
After last E	-.057	-.022	-.021	.042	.002	-.008	.085	**.186 ***	-						
Before 1^{st} L	**-.178 ****	-.083	**.141***	-.002	-.074	.039	**.218 ****	.109	**.302 *****	-					
Between L	**-.142 ***	-.007	.064	.035	-.041	-.018	.128	.100	**.329 *****	**.841 *****	-				
After last L	-.046	.018	-.015	.078	-.024	-.053	.090	.043	**.259 *****	**.640 *****	**.660 *****	-			
Before 1^{st} N	.051	.197	-.121	.034	.150	.247	-	-	-	-	-	-	-		
Between N	.071	**.307 ***	-.225	.025	.082	-.029	-	-	-	-	-	-	.319	-	
After last N	.134	.264	-.088	.037	-.020	-.020	-	-	-	-	-	-	**.351 ***	**.503 ****	-
Between rest	-.076	-.057	-.016	.001	-.083	.109	.147	.049	**.327 *****	**.540 *****	**.542 *****	**.464 *****	.224	.138	.028

*** $p<.001$; ** $p<.01$; * $p<.05$

6.3.1.2. Reduction of Modifier Variables

Although regression analysis is a powerful method of investigation it brings with it a number of assumptions. Due to the relatively small cohort involved in the present study the most prominent of these was the much quoted criterion that for each independent variable, there must be five participants, although some researchers advocate that that the figure should be closer to 40 (Green, 1991; Tabachnick and Fidell, 2001). Originally, regression equations were due to be performed separately for the rotating without nights and night shift groups, however, given that there were only 222 cases in the former and 51 in the latter, analysis using the potential 30 independent variables was unacceptable. Indeed, when such analysis was performed, the modifiers explained over 75% of the variance amongst those working rotating shifts without nights and 99.9-100% of the total variance amongst nightworkers on each of the factors. In an attempt to remedy the situation 'shift type' was entered as a dummy variable giving a total cohort of 278. However, this did not address the total number of independent variables available and indeed, added another, taking the total to 31.

Using too many independent variables has two potential disadvantages: (1) it runs the risk of over-fitting the model by using variables which overlap, and (2) related to this last point, increases the potential for collinearity amongst the predictors leading to biased estimates of R^2 and inflated β-values making the model unstable and, therefore, meaningless. Therefore in an attempt to reduce their number, relationships between modifier variables were examined through Pearson's correlations. Table 6.7 shows the remaining 25 of the original 31 modifier variables used in further analysis.

As expected 'age' and 'number of years work experience' were highly positively correlated ($r_{(250)}=.926$, $p<.001$). Given that age has been linked to a number of circadian and personality variables and, by itself, to shiftwork tolerance, work experience was excluded from further analysis. Since temporary workers were more likely to be laid off than permanent employees the correlations between 'contract' and both 'number of years at the site' ($r_{(264)}=-.732$, $p<.001$) and 'contract' and 'experience of the present shift pattern' ($r_{(268)}=-.550$, $p<.001$) were hardly surprising. Only contract was retained.

Although a distinction could be made between full and part time workers, with only 11 part-time personnel in the cohort, tenure was excluded from further analysis. Finally, although support from the partner was an important modifier, it was only applicable to those 102 workers who were married or living with a partner. Exclusion of this item alone doubled the number of cases being entered into the regression equations. In order to investigate the impact of partners' support, separate regression analyses using only those individuals with partners were performed. However, this analysis did not find support from partners to be a significant predictor in any of the five factors.

Table 6.7. Modifier variables used in further analysis

Demographic	Circadian/Personality	Work related
Shift type	Perceived sleep need	Control over job pacing
Age	Morningness (CMS)	Control over shifts
Gender	Morningness (TAQ)	Job satisfaction
No. of children	Languidity/Vigorousness	Job freedom
Marital status	Flexibility/Rigidity	Job demand
Contract	Strength of preferences	
Shiftwork experience	Time awareness	
Locality	Extroversion/Introversion	
	SHLOC	
	Engagement	
	Pref. for evenings (VLTU)	
	Pref. for weekends (VLTU)	

As a result of the inter-correlations between many of the work related modifiers an attempt was made to further reduce the variables in this category. Principal Components Analysis with Varimax rotation extracted 3 well-defined factors that between them accounted for 62.03% of the total variance. Factor 1, accounting for 24.12% contained workload, job demand and decision latitude. With loadings ranging between .741 to .804, reliability analysis showed no item to reduce the total scale alpha of .6558. As suggested by the correlation of $r_{(261)}=.614$ ($p<.001$) between control over shifts and the specific start and finish times, both loaded highly (above .855) on a second factor that accounted for 21.24% of the variance. Reliability analysis indicated an acceptable total scale alpha of .7799. Factor 3 accounted for 16.67% of the variance and contained job pacing, job freedom and general job satisfaction. In relation to the previous dimensions loadings were low (.357 to .666) as was the scale alpha at .3019. From this only the first two factor structures were retained, using the standardised scores (z transformation) for each item. Factor 1 was termed "Job Demand". Factor 2 was termed "Control over shifts". Items in Factor 3 were treated separately in further analysis.

6.3.1.3. Differences between Shift Types

In order to assess the relative impact of different shift types on the outcome measures, differences between the groups were examined. Descriptive statistics are shown in Table 6.8. Although nightworkers had better dietary behaviour and perceived their work pattern to have more advantages, in contrast, they experienced more problems than those working rotating shifts on all other factors, with more psychological health and sleep problems, more physical health problems, and more social and domestic interference. The two groups differed significantly from one another on preferences for daywork over shifts ($t_{(190)}=1.989$, $p<.05$), where those working rotating shifts had a stronger preference for days than those working permanent nights.

Differences were noted for sleep length, with nightworkers obtaining more sleep during successive rest days ($t_{(180)}$=1.996, p<.05). Amongst rotating shiftworkers, paired samples t-tests also revealed significant differences between the amount of sleep taken before the first work day of the shift cycle ($t_{(206)}$=27.399, p<.001) and between two successive work days ($t_{(197)}$=18.418, p<.001). In both instances those working rotating shifts obtained more sleep when working the late shift, with just under 3 hours extra before the first work day and over 2 hours extra between successive work days. This is illustrated in Figure 6.1.

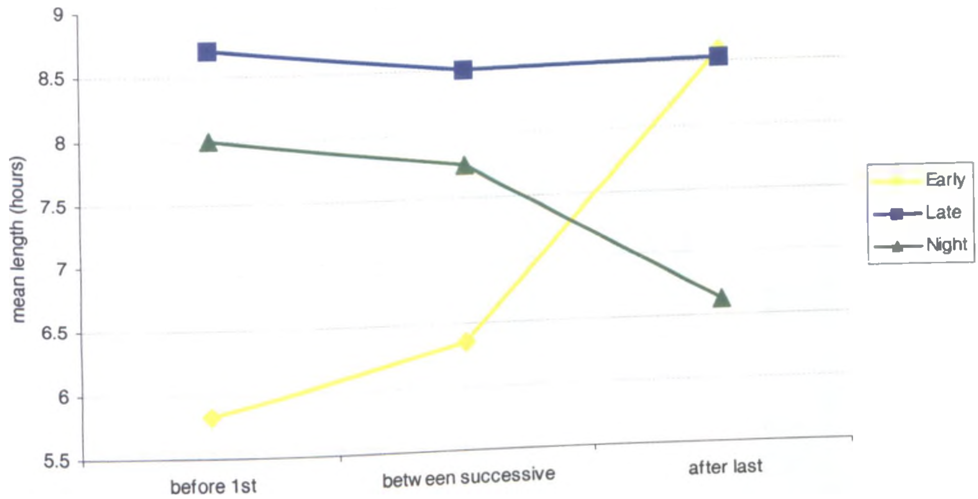
Table 6.8. Descriptive statistics for each outcome by shift type

	Rotating without nights		Permanent nights		t
	$\bar{x}$	(SD)	$\bar{x}$	(SD)	
Advantages of Shiftwork	0.02	(3.54)	-0.14	(3.13)	0.317
Preference for Daywork over Shifts	3.34	(1.42)	2.90	(1.42)	**1.989** *
Social & Domestic Disruption	0.08	(3.62)	0.37	(3.60)	0.806
Psychological Health & Sleep	-0.28	(6.03)	1.24	(6.65)	1.580
Physical Health	-0.13	(2.79)	0.55	(2.98)	1.516
Dietary Behaviour	0.06	(2.95)	0.03	(2.79)	0.728
Sleep Length:					
Between successive rest days	8.63	(1.31)	9.16	(1.70)	**1.996** *
Before first work day					
Early	5.83	(1.13)	-	-	-
Late	8.70	(1.28)	-	-	-
Night	-	-	8.00	(2.83)	-
Between successive work days					
Early	6.36	(1.09)	-	-	-
Late	8.50	(1.33)	-	-	-
Night	-	-	7.75	(0.35)	-
After last work day					
Early	8.58	(1.94)	-	-	-
Late	8.52	(1.52)	-	-	-
Night	-	-	6.62	(2.75)	-

*** p<.001; ** p<.01; * p<.05

In order to assess whether these differences could be linked to variations in the individual characteristics of the two groups, scores on all modifiers were compared across shift types. Findings showed the two groups to differ significantly on only 3 variables. The first was length of present shift experience with those working rotating shifts yielding an average of 34.72 months (SD 35.17) compared to just 15 months (SD 26.88) in permanent nightworkers ($t_{(265)}$=4.365, p<.001), the second being languidity/vigorousness with nightworkers being better able to overcome drowsiness ($\bar{x}$ 28.84; SD 3.50) compared to rotating workers ($\bar{x}$ 25.92; SD 3.49; $t_{(239)}$=5.057, p<.001), and the third being the job performance subscale of the SHLOC ($t_{(256)}$=2.161, p<.05; rotating: $\bar{x}$ 8.47, SD 1.97; permanent nights: $\bar{x}$ 9.143, SD 1.88). Here those working rotating shifts ($\bar{x}$ 8.48; SD 1.97) were more external than nightworkers ($\bar{x}$ 9.22; SD 1.92; $t_{(255)}$=2.404, p<.05).

Figure 6.1. Sleep length at different points of the shift system



Taking these findings into consideration it may be the case then that differences between the groups on these variables could explain the pattern of findings on outcome variables above, rather than variations in the work patterns. This was further explored with regression analysis detailed below.

Perceived Advantages and Disadvantages of Shiftwork

In order to examine the perceived advantages and disadvantages of shiftwork in a manner uncontaminated by the specific wording of questions, respondents were given three text boxes and asked "What are the three main advantages of your shift system for you?". This was repeated for the perceived disadvantages. Responses were classified into major domains, with no attempt to match outcome variables employed in the survey. The findings are illustrated in Figures 6.2 and 6.3.

Regardless of shift group, advantages relating to social and leisure activities were dominant throughout, and moreso amongst rotating shiftworkers with comments such as "allows me to have time to myself" and "being able to see my friends". Interestingly advantages related to family and domestic life were not very common, and perhaps more surprising given that 43.1% of respondents were married and 39.3% had 1 or more dependants. Moreover amongst nightworkers other advantages such as shift characteristics and the working environment were more important than domestic life.

Figure 6.2. Perceived advantages by shift type amongst production line workers

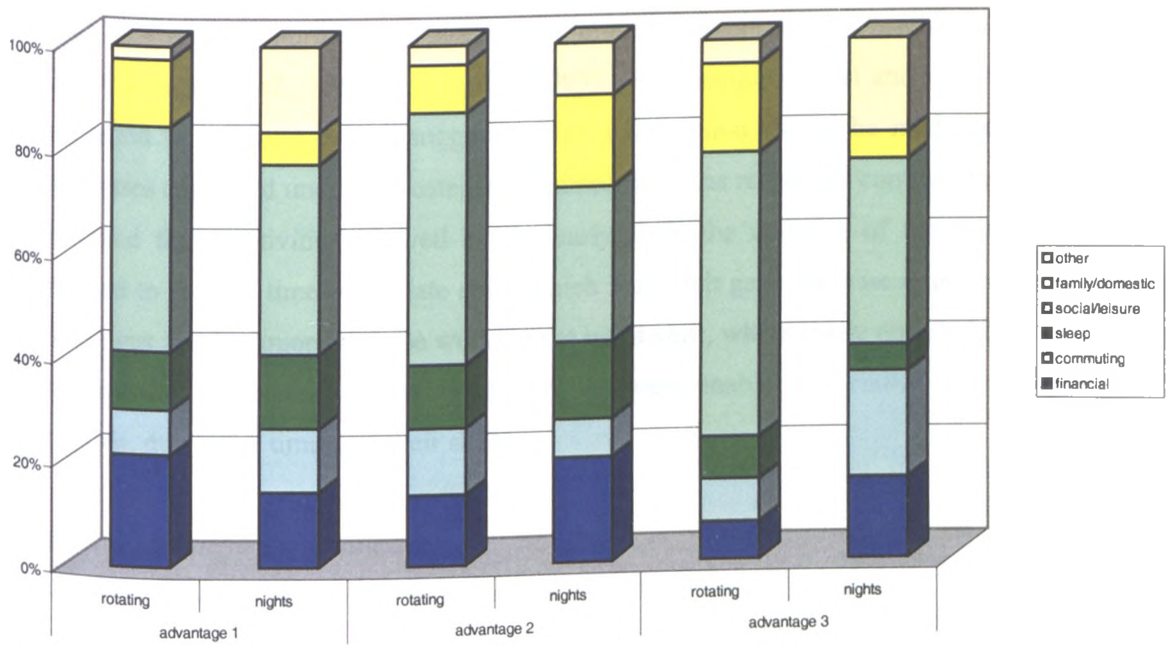
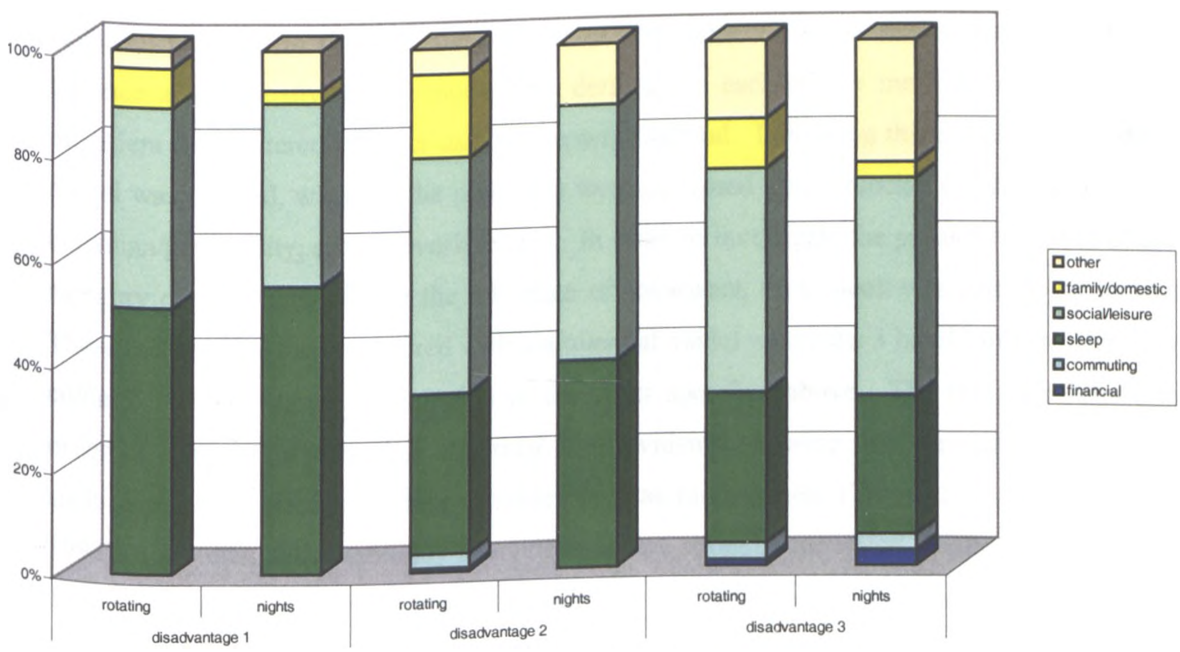


Figure 6.3. Perceived disadvantages by shift type amongst production line workers



The lack of reported advantages related to family and domestic activities was not explained by the disadvantages data either, as shown in Figure 6.3. Whilst those working rotating shifts expressed more problems in this area compared to permanent nightworkers, the percentage was nevertheless relatively small. In contrast the paucity of sleep related advantages was reflected here with both groups identifying fatigue or sleep disruption as an important disadvantage of their work pattern, supporting the wealth of literature advocating that, of all problems associated with shiftwork, disturbance of sleep is the most inevitable and far reaching (e.g. Foret *et al.*, 1980; Knauth *et al.*, 1982; Harrington, 1993). Surprisingly, social and leisure activities were reflected to a similar extent, suggesting that a distinction should be made between particular activities classified under this category. Indeed, whereas responses contained under advantages covered those activities allowed by the early shift, the majority of the disadvantages were related to the end time of the late shift, which many felt gave them no opportunity to socialise. This was similar amongst those working the night shift, where many reported that they enjoyed having time to themselves during the day but were unable to socialise in the evenings with friends, due to the timing of their shifts.

6.3.1.4. Multivariate Analysis

In order to examine the predictive validity of the modifier variables, a series of regression analyses were performed. Summary statistics are presented in Tables 6.9, 6.10, and 6.11. Modifiers were treated as independent variables, whilst each of the mega-factors were entered in turn as the dependent variable. Large amounts of missing data occurred within the circadian/personality variables, since on the majority of measures, a score was only derived when a response had been given for each item within the scale. Thus missing values were excluded pairwise to optimise the number of respondents used in the analysis. In the first instance a statistically driven model was derived for each of the mega-factors whereby all modifiers were entered together using a stepwise method. Following this a theoretically driven model was derived, whereby the modifiers were collapsed into 3 blocks: (1) demographic, (2) circadian/personality, and (3) work related. In order to investigate the predictive power of each category of modifiers without the influence of covariates, each block was entered on its own. These results were then compared with a sequential model where the 3 blocks of modifiers were entered into one regression equation in the order specified above. The rationale behind the order of entry in these models stemmed from evidence showing that demographic variables, such as age, can affect circadian variables such as morningness (Torsvall *et al.*, 1980; Adan, 1992). Circadian and personality characteristics are strongly correlated (Blake, 1967; Kerkhof, 1985a; Singer *et al.*, 1990). Together demographic and circadian/personality variables can affect such dimensions as job satisfaction and job demand (Spector *et al.*, 1994) that in turn can affect the ability to tolerate shiftwork. By entering the modifiers in 3 ordered blocks, their relative predictive power with all other variables held constant could be examined in an attempt to assess the amount of unique variance they predicted. This would reveal which variables strengthened or counteracted one another. The following section summarises the results of this analysis.

Table 6.9. Summary statistics for stepwise regression amongst production line workers

Outcome		Predictors	R^2 change	F change	df	β
Advantages of Shiftwork		General Job Satisfaction	.297	58.623***	1,164	.483***
		LOC	.045	9.534**	1,163	.217**
		Locality	.022	4.771*	1,162	.150*
Preference for Daywork		General Job Satisfaction	.169	28.232***	1,139	-.290***
		LOC	.075	13.731***	1,138	-.246**
		Gender	.043	8.274**	1,137	.201**
		Shiftwork Experience	.035	6.970**	1,136	-.188**
Social & Domestic Disruption		LOC	.190	32.623***	1,164	-.350***
		General Job Satisfaction	.046	8.251**	1,163	-.230***
Psychological Health & Sleep		LOC	.149	24.281***	1,164	-.245***
		Languidity/Vigorousness	.084	15.060***	1,163	.247***
		Contract type	.061	11.877***	1,162	-.288***
		General Job Satisfaction	.058	12.249***	1,161	-.222***
		Extroversion	.036	8.029**	1,160	-.229***
		Age	.023	5.282*	1,159	-.162*
Physical Health		Languidity/Vigorousness	.118	18.558***	1,164	.303***
		LOC	.038	6.133*	1,163	-.202**
		Job Demand	.027	4.535*	1,162	.167*
Dietary Behaviour		Morningness (TAQ)	.046	6.671*	1,139	.180*
		LOC	.030	4.422*	1,138	.176*
Sleep Length:						
Before first shift	Early	General Job Satisfaction	.066	8.238**	1,117	.229**
		Perceived sleep need	.033	4.276*	1,116	.227*
		Morningness (CMS)	.041	5.415*	1,115	.210*
	Late	Shiftwork experience	.060	7.474**	1,117	-.245**
	Night	Age	.216	5.520*	1,20	-.600**
		Preference for mornings	.151	4.546*	1,19	.412*
Between successive shifts	Early	No predictors	-	-	-	-
	Late	Shiftwork experience	.098	12.764***	1,117	-.248**
		Age	.039	5.214*	1,116	-.208*
	Night	Flexibility/Rigidity	.264	7.188*	1,20	.514*
After last shift	Early	No predictors	-	-	-	-
	Late	Number of children	.045	5.570*	1,117	-.213*
	Night	No predictors	-	-	-	-
Between successive rest days		Age	.055	7.842**	1,134	-.204*
		Time Awareness	.033	4.858*	1,133	-.209*
		Shift type	.030	4.455*	1,132	-.174*

* p<.05; ** p<.01; *** p<.001

Table 6.10. Summary statistics for hierarchical regression (individual blocks) amongst production line workers

		Demographic		Circadian/Personality		Work related	
		R^2	F	R^2	F	R^2	F
Advantages of Shiftwork		.072	2.464*	.203	2.712**	.336	24.938***
Preference for Daywork		.164	5.527***	.243	3.425***	.216	13.523***
Social & Domestic Disruption		.078	2.684**	.252	3.595***	.146	8.444***
Psychological Health & Sleep		.134	4.903***	.337	5.433***	.220	13.903***
Physical Health		.056	1.875	.202	2.702**	.102	5.603***
Dietary Behaviour		.020	0.655	.093	1.094	.032	1.650
Sleep Length:							
Before first shift							
	Early	.060	0.857	.176	1.893*	.076	3.291**
	Late	.183	2.941**	.148	1.530	.055	2.249
	Night	.325	0.482	.467	0.657	.046	0.273
Between successive shifts							
	Early	.037	0.484	.095	0.929	.034	1.315
	Late	.209	3.330**	.160	1.686	.065	2.573*
	Night	.368	0.655	.580	1.035	.094	0.644
After last shift							
	Early	.062	0.833	.100	0.982	.004	0.137
	Late	.126	1.840	.151	1.572	.016	0.561
	Night	.244	0.362	.733	2.057	.094	0.623
Between successive rest days		.103	1.245	.121	1.417	.016	0.547

*** p<.001; ** p<.01; * p<.05

Table 6.11. Summary statistics for hierarchical regression (sequentially) amongst production line workers

		Demographic		Circadian/Personality		Work related	
		R^2	F	R^2 change	F change	R^2 change	F change
Advantages of Shiftwork		.072	1.281	.170	2.239*	.182	7.289***
Preference for Daywork		.164	2.862**	.187	2.853**	.063	2.445*
Social & Domestic Disruption		.078	1.395	.207	2.901***	.039	1.312
Psychological Health & Sleep		.134	2.548*	.294	5.142***	.060	2.684*
Physical Health		.056	0.978	.185	2.440**	.051	1.662
Dietary Behaviour		.020	0.341	.092	1.033	.014	0.362
Sleep Length:							
Before first shift							
	Early	.060	0.608	.146	0.978	.035	0.539
	Late	.183	2.128*	.113	0.855	.011	0.184
	Night†	-	-	-	-	-	-
Between successive shifts							
	Early	.037	0.361	0.79	0.479	.018	0.247
	Late	.209	2.506*	.133	1.080	.010	0.177
	Night†	-	-	-	-	-	-
After last shift							
	Early	.062	0.627	.090	0.569	0.10	0.145
	Late	.126	1.371	.129	0.928	.024	0.388
	Night†	-	-	-	-	-	-
Between successive rest days		.103	1.169	.116	0.986	.005	0.092

*** p<.001; ** p<.01; * p<.05; † Night shift cohort was too small for regression analysis to be conducted.

Perceived Advantages of Shiftwork

As can be seen in Table 6.9, when all modifiers were entered into the stepwise model, perceived advantages of shiftwork were predicted by 3 variables: 'satisfaction and contentment with the job', 'LOC' and 'how far the respondent lived from the site', between them accounting for 36.4% of the variance. Of the three, satisfaction and contentment with the job was the most important, accounting for 29.7% of this total ($F=58.623$, $p<.001$), where a positive β-weight ($\beta=.483$, $p<.001$) suggested that greater satisfaction was associated with the perception of more advantages. LOC accounted for a further 4.5% (F change=9.534, $p<.01$), with a positive β-weight ($\beta=.217$, $p<.01$) indicating an association between internality and more advantages. Finally, accounting for the lowest proportion of the variance (R^2 change= .022, F change=4.771, $p<.05$) was 'locality'. Contrary to the expected result, $\beta=.150$ ($p<.05$) suggested that workers who lived farther away from the site perceived shiftwork as offering them more advantages than those who lived nearby. A possible explanation for such a trend is the idea that, since shiftwork is associated with a number of negative outcomes, those who live further away from their place of work perceive more reward in their work pattern, and so are willing to travel further in order to obtain them.

When entered as a single block, demographic variables significantly predicted 7.2% of the total variance in perceived advantages of shiftwork ($F=2.464$, $p<.05$), with only 'gender' adding significantly to the equation. Here males were more likely than females to perceive shiftwork as offering them advantages ($\beta=-.137$, $p<.05$). Circadian/personality variables entered together as a single block accounted for 20.3% of the total variance ($F=2.712$, $p<.01$), with only an internal LOC contributing significantly ($\beta=.367$, $p<.001$).

Finally, work related variables had the highest predictive power of all three modifier categories, accounting for 33.6% ($F=24.938$, $p<.001$). Within this category, 'satisfaction and contentment with the job' ($\beta=.473$, $p<.001$), 'pacing of the job' ($\beta=.140$, $p<.01$) and 'work demand' ($\beta=.118$, $p<.05$) significantly added to the equation, although 'control over shifts' approached significance ($\beta=.101$, $p=.058$). Indeed, only one variable within the work related category failed to reach or approach significance, that of 'job freedom' ($\beta=-.023$, $p=.663$), underlining the strength of variables within this category.

Hierarchical multiple regression found that, after the entry of demographic variables in step 1, circadian/personality variables entered in a single block in step 2 accounted for a further 17% of the variance, significantly improving the prediction of perceived advantages of shiftwork (F change=2.239, $p<.05$). Inspection of the β-weights showed 'LOC' to be the only modifier in this category to add significantly to the equation (β=.328, $p<.001$). Work related variables in step 3 accounted for the highest proportion of the variance, contributing a further 18.2% (F change=7.289, $p<.001$). Within this final model, only 'satisfaction and contentment with the job' significantly added to the equation (β=.423, $p<.001$), with 'LOC' approaching significance at β=.166 (p=.059).

Summary

Thus, taken together the results suggest that of the categories of modifier variables included in the analysis, work related variables were the strongest in predicting the perceived advantages of shiftwork. This conclusion is supported by the fact that work related variables contributed the highest proportion of the variance when the mediating effects of demographic and circadian/personality modifiers were held constant, even though its total variance was halved from 33.6% when tested in isolation, to 15.4% when entered in the hierarchical model. Furthermore the change in F associated with the entry of work related variables in step 3 was the most significant of the three stages. Furthermore, examination of the β statistics showed the work related modifier of satisfaction and contentment with the job to be the most important predictor of all variables entered into the model.

Preference for Daywork over Shifts

In support of the strong correlation between this measure and the perceived advantages of shiftwork, similar predictors emerged. The strongest of these was 'general job satisfaction' that accounted for 16.9% of the total variance (F=28.232, $p<.001$) and had a β-weight of -.290 ($p<.001$) suggesting an association between low satisfaction and a stronger preference for daywork. The second variable was 'LOC', accounting for a further 7.5% of the total variance (F change=13.731, $p<.001$). Here, a β-weight of -.246 ($p<.01$) suggested that those with a tendency toward externality were more likely to prefer daywork. Two final predictors, that of 'gender' and 'shiftwork experience' also entered the equation, explaining similar proportions of the variance on this measure (4.3% and 3.5% respectively). Here males and those with less experience showed a stronger preference for days.

When entered as a single block, demographic variables predicted the least amount of variance (R^2=.164, F=5.527, $p<.001$) with only 'gender' (β=.234, $p<.001$) and 'shiftwork experience' (β=-.138, $p<.05$) adding significantly to the equation. Circadian/personality variables entered as a single block significantly predicted 24.3% (F=3.425, $p<.001$), where, internality (β=-.383, $p<.001$), and a tendency toward morningness on both the TAQ (β=.227, $p<.05$) and CMS (β=.-.230, $p<.05$) were the only modifiers to reach significance. Finally, work related variables, entered in a single block, significantly accounted for 21.6% of the total variance (F=13.523, p<.001), where satisfaction and contentment with the job (β=-.338, p<.001), job demand (β=-.168, p<.01) and control over the shifts worked (β=-.124, p<.05) reached significance.

Hierarchical regression analysis showed that after the entry of demographic variables in step 1, circadian/personality variables in step 2 significantly explained a further 18.7% of unique variance (F change=2.853, p<.001), with LOC (β=-.297, p<.001) being the only modifier to add significantly to the model. Work related variables entered in step 3 accounted for a further 6.3%, and again showed a significant change (F change=2.445, p<.05). Inspection of the β-weights in this final model generally supported the stepwise equation, with LOC (β=-.217, p<.05), satisfaction and contentment with the job (β=-.249, p<.01) gender (β=.225, p<.01) and TAQ morningness (β=.238, p<.05) reaching acceptable levels.

Summary

Findings from the hierarchical regression suggests that demographic variables have a moderate, albeit weak, mediating impact upon the predictive power of circadian/personality variables in the prediction of a preference for daywork over shifts, with a reduction of 5.6% when demographic variables were held constant. When the effects of both demographic and circadian/personality variables had been held constant, the unique predictive power of work related variables was reduced from 21.6 to 6.3%, a reduction of 15.3%. Thus, in terms of a preference for daywork, demographic variables were found to have a mediating impact upon the predictive power of circadian/personality modifiers, whereas the two categories together had a substantial impact upon the predictive power of work related modifier variables. Overall, circadian/personality modifiers were the most important in predicting this attitude measure.

Social and Domestic Disruption

Of the 25 modifier variables entered into the stepwise procedure, only two were extracted as predictors of social and domestic disruption. The strongest of these was 'LOC' that accounted for 19% of the total variance (F=32.623, p<.001) and had a β-weight of -.350 (p<.001) suggesting an association between internality and less social and domestic disruption. The second variable was 'satisfaction and contentment with the job' accounting for a further 4.6% of the total variance (F change=8.251, p<.01). Here a β-weight of -.230 (p<.01) suggested that greater satisfaction was associated with less disruption.

When entered as a single block, demographic variables predicted only 7.8% of the total variance (F=2.684, p<.01) with only 'age' (β=-.195, p<.01) and 'shiftwork experience' (β=-.136, p<.05) adding significantly to the equation. Thus, older workers and those with greater shiftwork experience reported less social and domestic disruption. Circadian/personality variables significantly predicted 25.2% of the variance ($F=3.595$, $p<.001$), where an internal LOC ($\beta=-.418$, $p<.001$) and weak early/late preferences ($\beta=.184$, $p<.05$) were the only modifiers within this category to be associated with less social and domestic disruption. Finally, work related variables significantly accounted for 14.6% of the total variance in social and domestic disruption ($F=8.444$, $p<.001$), where, in support of the stepwise analysis, only satisfaction and contentment with the job had a significant β-weight ($\beta=-.359$, $p<.001$).

Hierarchical regression analysis showed that after the entry of demographic variables in step 1, circadian/personality variables in step 2 significantly explained a further 20.7% of unique variance (F change=2.901, $p<.001$), with LOC ($\beta=-.382$, $p<.001$) and strength of early/late preferences ($\beta=.192$, $p<.05$) being the only modifiers within this category to add significantly to the model. Work related variables entered in step 3 accounted for a further 3.9%, but failed to add significantly to the solution (F change=1.312, $p<.05$). Inspection of the β-weights in this final model supported the stepwise equation, where only LOC ($\beta=-.290$, $p<.01$) and satisfaction and contentment with the job ($\beta=-.199$, $p<.05$) reached an acceptable level.

Summary

The findings from this final hierarchical regression suggest that demographic variables have a moderate mediating impact upon the predictive power of circadian/personality variables on social and domestic disruption, with a reduction of 4.5% when demographic variables were held constant. When the effects of both demographic and circadian/personality variables had been held constant, the unique predictive power of work related variables decreased from 14.6 to 3.9%, a reduction of 10.7%. Thus, in terms of social and domestic disruption, demographic variables were found to have a mediating impact upon the predictive power of circadian/personality modifiers, whereas the two categories together had a substantial impact upon the predictive power of work related modifier variables. Overall, circadian/personality modifiers were the most important in predicting social and domestic disruption.

Psychological Health and Sleep Problems

When entered in a stepwise model, 6 modifiers were extracted as predictors of psychological health and sleep problems, between them accounting for 41.1% of the total variance. 'LOC' accounted for the biggest proportion, explaining 14.9% ($F=24.281$, $p<.001$), with a negative β-weight ($\beta=-.245$, $p<.001$) indicating that a tendency toward internality was associated with fewer psychological health and sleep problems. Although 'languidity' predicted less of the total variance (R^2 change=.084, F change=15.060, p<.001), a β-weight of .247 (p<.001) indicated that an inability to overcome drowsiness was a stronger predictor of psychological health and sleep problems than LOC. However, the strongest predictor overall was the demographic variable of 'contract type'. Accounting for only 6.1% of the total variance (F change=11.877, p<.001) being employed on a temporary contract at the site was associated with poorer psychological health and sleep in relation to those on a permanent contract (β=-.288, p<.001).

Of the remaining predictors, 'satisfaction and contentment with the job' accounted for 5.8% (F change=12.249, p<.001) of the total variance where lower satisfaction was associated with poor psychological health and sleep (β=-.222, p<.001), whilst the personality dimension of 'extroversion' accounted for a further 3.6% (F change=8.029, p<.01). Here β=-.229 (p<.01) suggested that extroverted individuals experienced fewer psychological health and sleep problems. Finally, 'age' (R^2 change=.023, F change=5.282, p<.05), with a β-weight of -.162, indicated that younger employees were more likely to suffer psychological health and sleep problems in comparison to older workers at the site.

When entered as a single block, demographic variables predicted 13.4% of the variance (F=4.903, p<.001) in psychological health and sleep, although in support of the stepwise model, both 'contract type' (β=-.268, p<.001) and 'age' (β=-.173, p<.05) added significantly to the equation. Personality/circadian variables predicted a substantial proportion of the total variance (33.7%, F=5.433, p<.001) with 'LOC' (β=-.284, p<.001), 'languidity' (β=.203, p<.05) and 'extroversion' (β=-.231, p<.01) contributing significantly to the equation. Finally, work related variables predicted a large proportion of the variance, at 22% (F=13.903, p<.001). Whilst 'satisfaction and contentment of the job' showed a significant β-weight (β=-.417, p<.001), supporting the stepwise model, 'work demand' also added significantly to the equation (β=.271, p<.001).

Hierarchical multiple regression to eliminate the effects of covariates showed that after the entry of demographic variables in step 1, circadian/personality variables entered in step 2 significantly improved the prediction of psychological health and sleep problems, explaining 29.4% unique variance (F change=5.142, p<.001). Examination of the β statistics indicated that only 'LOC' and 'extroversion' added significantly to the model. Work related variables in step 3 predicted a unique variance of 6%, and resulted in a significant change (F change=2.684, p<.05). Inspection of the β-weights of variables in this final category showed 'satisfaction and contentment with the job' to be the only modifier to achieve significance, although 'work demand' with a β-value of .170 approached significance (p=.052). In the final model, with all 3 categories of modifiers entered, having an extroverted and internal personality, being satisfied and contented with the job, and being on a permanent contract were all predictors of fewer psychological health and sleep problems.

Summary

In summary, the fact that the amount of variance explained by circadian/personality variables changed by only 4.3% once the potential effects of demographic variables had been excluded, suggests that the modifiers within the demographic category had very little effect on these dimensions. However, the most substantial change was seen for the work related variables which changed from predicting 22% of the variance when tested in isolation, to a much smaller 6% when entered in step 3 of the hierarchical model. This supports the idea that some of the modifiers contained within this category were mediated by demographic and circadian/personality categories. Overall, the hierarchical model indicated that of the modifiers entered, circadian/personality characteristics were most important in the prediction of psychological health and sleep problems in the present cohort.

Physical Health

Using the stepwise method, 3 modifiers were extracted as predictors of physical health problems. 'Languidity' predicted the largest proportion of the variance at 11.8% ($F=18.558$, $p<.001$), where a β-weight of .303 ($p<.001$) suggested that being a languid type was associated with more problems. The second most important predictor was that of 'LOC', that contributed a further 3.8% (F change=6.133, $p<.05$). A negative β-weight of -.202 showed internal types to suffer fewer problems covered by the physical health category. Finally, 'job demand' accounted for a small, but further amount, of 2.7% (F change=4.535, $p<.05$; $\beta=167$, $p<.05$). Having the weakest predictive power of all variables included in the final model, those employees who perceived their work to be demanding and offering less opportunity for decisions, experienced greater physical health problems.

When entered on their own, demographic variables accounted for only 5.6% of the total variance in physical health, although this figure failed to reach significance ($F=1.875$, $p>.05$). Inspection of the β statistics of modifiers within this category showed only 'contract type' to reach significance ($\beta=-.156$, $p<.05$) suggesting that temporary workers suffered more physical health problems when compared to those employed on a permanent basis. Supporting the picture gained so far, circadian/personality variables, when entered as a single block, significantly predicted a substantial amount of the variance in physical health, at 20.2% ($F=2.702$, $p<.01$). Here, only 'languidity' had a significant β-weight ($\beta=.020$, $p<.05$), with 'LOC' being the next variable to approach, but not reach, significance ($\beta=-.167$, $p=.055$).

Finally, when work related variables were forced into the model in a single block, its predictive power was relatively high at 10.2% ($F= 5.603$, $p<.001$). In this category a high work demand ($\beta=.249$, $p<.001$) and less satisfaction and contentment with the job ($\beta=-.202$, $p<.01$) were the only modifiers to add significantly to the solution. Interestingly, although the modifier failed to reach significance, analysis of the β values suggested that those who perceived themselves to have more control over both the shifts they worked and the specific start and finish times of those shifts actually suffered more physical health problems ($\beta=.113$, $p=.067$).

Hierarchical regression analysis showed that, after the entry of demographic variables in step 1, circadian/personality variables in step 2 *significantly* improved the prediction of physical health problems, accounting for 18.5% of unique variance (F change=2.440, $p<.01$). Inspection of the β-weights showed 'LOC' to be the only modifier in this category to add significantly to this stage of the equation ($\beta=-.193$, $p<.05$). Work related variables entered in step 3 predicted a further 5.1%, but failed to significantly improve the predictive power of the model (F change =1.662, $p>.05$). In this final model only one variable had a significant β-weight, that of 'work demand', where $\beta=.243$ ($p<.05$) suggested that employees who perceived their work to be demanding experienced more physical health problems.

Summary

In summary, holding demographic variables constant resulted in the proportion of variance explained by circadian/personality variables to decrease from 20.2% to 18.5%, a total of 1.7%, suggesting, as before, that demographic variables have some, albeit weak, mediating influence over modifiers within the second category. In support of the hypothesis that demographic and circadian/personality variables would mediate the impact of work related modifiers, the predictive power of modifiers within the work related category was halved from 10.2% to 5.1% when the former two categories were held constant. Thus, as with previous outcomes, circadian/demographic variables accounted for the highest proportion of variance in physical health amongst the workers.

Dietary Behaviour

As shown in Table 6.9, when all modifiers were entered in a stepwise model, dietary behaviour was predicted by 'TAQ morningness' and 'LOC', that, between them, accounted for 7.6% of the total variance. Morningness was the most important of the two, accounting for 4.6% of this total ($F=6.671$, $p<.05$), where a positive β-weight ($\beta=.180$, $p<.05$) suggested that a tendency toward morningness was the stronger variable in the frequency of meals consumed and whether these meals were perceived as being balanced and nutritious. LOC accounted for a further 3%

of the variance (F change=4.422, $p<.05$), where $\beta=.176$, $p<.05$ suggested that internality was associated with better eating habits.

When entered as a single block, demographic variables predicted only 2% (F=.655, $p>.05$), of the variance in dietary behaviour, with no single variable adding significantly to the equation. In contrast, circadian/personality variables predicted 9.3% of the variance, although this failed to yield a significant equation (F=1.094, $p>.05$). Finally for work related variables, the predictive power was again low at just 3.2% (F=1.650, $p>.05$).

After the entry of demographic variables in step 1 circadian/personality variables in step 2 explained a further 9.2% of the variance, but did not significantly improve the prediction of dietary behaviour (F change =1.033, $p>.05$). Inspection of the β-weights showed LOC to be the only modifier in this category to add significantly to the equation ($\beta=.196$, $p<.05$), with TAQ morningness being the next variable to approach significance ($\beta=.166$, $p=.152$). Work related variables in step 3 predicted a unique variance of 1.4% but, as with the former category, failed to add significantly to the equation (F change=.362, $p>.05$). Inspection of the β-weights in this final model supported earlier analysis with LOC and TAQ morningness being the only modifiers to approach, but not reach significance.

Summary

Thus in conclusion, the fact that the amount of variance explained by circadian/personality modifiers changed by only 0.1% once the potential effects of demographic factors had been held constant suggests that demographic variables have very little influence on these dimensions. However, since the predictive power of work related variables changed from 3.2% when tested in isolation to 1.4% when tested with the remaining modifiers it suggests that some of the variables contained within the category are mediated by variables in the former two categories. Taken together, however, in terms of dietary behaviour circadian/personality characteristics were most important.

Sleep Length

When all modifiers were entered in a stepwise model few predictors emerged for sleep length. For example, accounting for 14% of the variance overall, 'general job satisfaction', 'perceived sleep need' and 'morningness' (CMS) were extracted for sleep length before the first early shift, with positive β-weights in all cases indicating that greater satisfaction ($R^2=0.66$, F=8.238, $p<.01$; $\beta=.229$, $p<.01$), a longer sleep need (R^2 change=.033, F change=4.276, $p<.05$; $\beta=.227$, $p<.05$) and a tendency toward morningness (R^2 change=.041, F change=5.415, $p<.05$; $\beta=.210$, $p<.05$) were associated with a longer sleep. For the late shift, only 'shiftwork experience' emerged (R^2=.060, F=7.474, p<.01), where β=-.245 (p<.01) suggested that sleep length decreased as experience increased. A separate set of predictors were also extracted for the length of sleep before the first night shift of the cycle where both increasing 'age' (R^2=.216, F=5.520, p<.05; β=-.600, p<.05) and 'a preference for evenings over mornings'(VLTU) (R^2 change=.151, F change=4.546, p<.05; β=.412, p<.05) were associated with more sleep.

In terms of the length of sleep between successive shifts, during the early shift, no modifiers were entered into the equation. Increasing experience (R^2=.098, F=12.764, p<.001; β=-.248, p<.01) and age (R^2 change=.039, F change=5.214, p<.05; β=-.208, p<.05) were both associated with less sleep between successive late shifts. For sleep between successive night shifts, only 'flexibility' entered the model. This accounted for 26.4% of the variance (F=7.188, p<.05), where β=.514 (p<.05) indicated that a tendency toward flexibility was associated with more sleep. For sleep after the final work day of the cycle, no predictors emerged for the early or night shift. Furthermore, for the late shift, only the 'number of children' was extracted, predicting 4.5% of the variance (F=5.570, p<.05). β=-.213 (p<.05) indicated that more sleep was gained by those who had fewer children.

Sleep gained between successive rest days, was predicted by three variables, between them accounting for 11.8%. 'Age' emerged as the most important of these, predicting 5.5% (F=7.842, p<.01) with 'time awareness' predicting 3.3% (F change=4.858, p<.05) and 'shift type' a further 3.0% (F change=4.455, p<.05). Negative β-weights in all cases suggested that less sleep was obtained by older workers (β=-.204, p<.05), those with good time awareness (β=-.209, p<.05) and those working rotating shifts (β=-.174, p<.05).

When entered as a single block, demographic variables significantly predicted sleep length before the first late shift (R^2=.183, F=2.941, p<.01) and between successive late shifts (R^2=.209, F=3.330, p<.01) only, where in both cases it was the only set of predictors to reach significance. For the latter, work related variables also significantly predicted 6.5% (F=2.573, p<.05). As can be seen from Table 6.10, the only other significant equations were found for sleep length before the first early shift, where circadian/personality variables accounted for 17.6% (F=1.893, p<.05) with work related variables accounting for 10% less at 7.6% (F=3.291, p<.001). Inspection of the β-weights for both categories of modifiers supported the findings from stepwise analysis where, for the former, 'perceived sleep need' was the most important variable (although 'engagement' also reached significance), whilst for the latter, 'general job satisfaction' emerged as the only significant predictor. For sleep length of nightworkers, circadian/personality modifiers consistently accounted for the highest proportion of variance, although they failed to yield a significant model on any occasion.

When entered sequentially the predicted direction of effects was supported, with the entry of circadian/personality variables in step 2 and work related variables in step 3 failing to produce a significant increase in the predictive power of any of the models (although it should be noted that the nightshift cohort was too small to be subjected to this analysis), suggesting that they have a strong mediating effect. Furthermore only two of the final models contained significant β-values. For sleep length between successive rest days, 'time awareness' was the only variable to reach significance (β=-.273, $p<.05$), whilst, for sleep length before the first early shift, only 'perceived sleep need' reached an acceptable level (β=.317, $p<.05$).

Summary

Thus, taken together the results suggest few of the modifiers used in the analysis were strong predictors of sleep length. However, for the early shift, circadian/personality variables were most important, accounting for the highest proportion of variance both when tested in isolation and within the theoretically driven models. In contrast, for the late shift, demographic variables emerged as the most important, being the only variables entered into the stepwise equations, and accounting for the highest proportion of variance for sleep length before the first shift, and between successive shifts in hierarchical analysis. The same was true for the amount of sleep gained before, between and after the night shift as well as between successive rest days, although in this instance, demographic modifiers yielded the highest predictive power in all hierarchical models.

6.3.1.5. Locus of Control – further analysis

Since SHLOC (when used as a single measure rather than as separate subscales) contributed to the prediction of variance in all 5 outcome factors, further analysis using a stepwise regression model was conducted to examine which subscales of the measure were most important in each case. For eating behaviour and diet, only those items within the 'health' subscale were extracted, predicting a low proportion of the total variance (R^2=.024, F=6.085, $p<.05$; β=.156, $p<.05$). For psychological health and sleep, the 'work performance' and 'sleep' subscales significantly predicted 14.3% of the variance between them. Of the two scales, work performance was the most important, accounting for 9.5% of the variance (F=25.596, $p<.001$; β=-.245,$p<.001$). In comparison, the sleep subscale accounted for 4.8% (F change =13.545, $p<.001$) with a slightly lower β-weight of -.227 ($p<.001$). Analysis of variables not included in the final equation showed that the 'social life' subscale was the only other measure to approach significance (β=-.119, p=.063).

In terms of physical health, only one subscale, that of 'sleep' entered the equation. Accounting for only 3.2% of the total variance ($F=7.971$, $p<.01$) a relatively low β-value ($\beta=-.178$, $p<.01$) indicated that, whilst an important variable when tested with demographic, circadian/personality and work related measures, when tested in isolation its overall strength was lost. Examination of the excluded variables in this case showed that 'work performance' approached, but failed to reach, significance ($\beta=-.120$, $p=.067$). For social and domestic disruption, two of the LOC subscales emerged as predictors, between them accounting for 20.2% of the variance. As expected, the 'social life' subscale accounted for a high proportion of this ($R^2=.189$, $F=56.959$, $p<.001$) and, as such, was the most important with a β-weight of -.385 ($p<.001$). The second scale included in the equation was 'sleep' although this accounted for a small proportion of the variance at only 1.6% (F change=4.853, $p<.05$; $\beta=-.135$, $p<.05$). The 'social life' subscale also emerged as the most important predictor of perceived advantages of shiftwork, accounting for 16.9% of the total variance ($F=49.966$, $p<.001$). A high β-value ($\beta=.359$, $p<.001$) further underlined this importance. However, also included in this equation was the 'health' subscale, although this accounted for only 1.6% (F change=4.916, $p<.05$; $\beta=.139$, $p<.05$).

6.4. Discussion

In support of the interviews, exploratory factor analysis of the outcome variables revealed that they could be grouped succinctly into major domains. The strongest of these was 'psychological health and sleep disturbance', that included measures of psychological health, anxiety, neuroticism and the use of disengagement strategies, in addition to sleep disturbances, fatigue and alertness. Inter-correlations between items within this dimension suggested that sleep disturbances were most strongly associated with impairments to psychological rather than physical health, or indeed any of the factors derived. This, in general, supports the interaction of events derived from the interviews where, for the early shift (Figure 5.1a) especially, impaired sleep was linked, in one branch, to high levels of fatigue which formed an independent pathway to irritability and anxiety, and in another branch, to impaired alertness and concerns about road safety. Likewise, for nightworkers (Figure 5.1c), day sleep was associated with a higher level of sleep disruption (as a result of noise, interruptions to join in with the family and in order to run errands) again leading to fatigue and irritability.

The second factor, 'social and domestic disruption', contained only those items relating directly to social and domestic impairments. In recognition of the fact that shiftwork can also have a positive impact on workers, the third factor, 'perceived advantages of shiftwork', contained the four subscales of the advantages of shiftwork questionnaire, along with the single item asking whether the advantages of shiftwork outweighed the disadvantages. The fourth factor contained all subscales of the physical health questionnaire. Interestingly, cognitive fatigue, cognitive and somatic anxiety and perceived problems with both health and well-being and dietary behaviour loaded highly on this dimension suggesting some association between these variables. Finally, factor 5, labelled 'dietary behaviour' contained items related to the frequency of specific meal types along with the perceived nutritious value of the meals eaten. Thus, although analysis was able to reduce the original 39 outcome variables to just 5 major domains, analysis of the factor loadings suggested some relationship between them.

The strength of interactions amongst outcome variables was further explored by correlating the five factors against one another. This showed the strongest overall relationship to be between psychological health and sleep and physical health, which, considering the fact that a number of variables loaded on both factors, was not surprising. The direction of association here was such that a shiftworker who reported greater psychological health and sleep problems also tended to report greater physical health symptoms. Psychological health and sleep was also significantly correlated with the three remaining factors. Thus a participant who reported greater psychological health and sleep problems also tended to suffer social and domestic disruption, to perceive shiftwork as offering fewer advantages and to have poorer dietary habits. Interestingly, on the latter point, Figures 5.1a and 5.1c incorporate pathways from sleep disturbances to poor dietary behaviour. For the early shift, poor sleep led, through a number of pathways, to missing the midday meal and snacking, which in turn caused a negative impact on sleep, since snacking too close to bedtime was found to increase alertness and therefore affected the ability to drop off to sleep. On the night shift, sleeping during the day and working during the night were both found to lead to an impaired appetite, with workers snacking on convenience or snack foods rather than a main meal. However, rather than resulting in poor sleep, here there was a negative effect on gastrointestinal symptoms.

In the same vein, social and domestic disruption showed significant associations with all factors. The relationship between disruption and perceived advantages of shiftwork was perhaps indicative of the fact that the majority of items on the advantages scale related to social and family events (e.g. "shiftwork is good for seeing friends", and "shiftwork is convenient for domestic responsibilities"). Again the strength of associations between social and domestic disruption and psychological health and sleep supports the proposed interaction of events derived at the interview stage. Whilst not applicable to the late shift, for the early shift, truncated and disturbed sleep led to impaired social and family life through two pathways: (1) through high levels of fatigue, and (2) via napping (see Figure 5.1a). For the night shift, sleeping during the day led to little interaction with society which, through depression on one hand, and independently on the other, led to feelings of isolation. Furthermore, there was also a direct pathway from day sleep to impaired social and family life.

The association between social and domestic disruption and eating behaviour, was perhaps not surprising given that, during the interviews, many workers commented that because of their work or sleeping patterns, they often missed out on the family meal. For some this was the only opportunity they had for the family to be together. However, extending this theme, it is interesting to note that there was no association between dietary behaviour and physical health. Indeed physical health was the only factor that failed to correlate with eating habits. Given that the physical health factor contained gastrointestinal symptoms such as disturbance of appetite, and frequency of digestive complaints (e.g. heartburn, stomach-ache or nausea), such a finding suggests that the disturbance of appetite reported by participants in the present study were more strongly linked to other factors such as the timing of sleep and missing out on the family meal. During the interviews, a number of nightworkers stated that, because of their work pattern, the timing of their meals was altered so that they found themselves eating their main meal of the day at 1:30 in the morning. Because this was not seen as a natural meal break, many commented that they found it difficult to eat at this time, due to a lack of appetite. In other circumstances the timing of sleep meant that workers missed out on natural mealtimes and so combined breakfast and lunch into one meal, or in other circumstances missed out on sleep to join in with the family meal even though they were not hungry. Thus in most scenarios, appetite and eating habits were impaired due to the working or sleeping regime of the individual rather than their physical state of health.

In terms of the relative importance of each of the problem domains, both the rotating shiftworkers and permanent nightworkers reported more problems with psychological health and sleep, followed by physical health symptoms, social and domestic disturbance, and dietary behaviour, with the perceived advantages of shiftwork being least important. Although it is difficult to compare directly the extent of problems here compared with the rankings given during the interviews, when taken together the two present a somewhat contradictory picture. For example for those working the early shift, sleep problems were rated as being the worst affected, followed by domestic and family life, health and well-being and social disruption, with eating behaviour being least affected. For the late shift, domestic and family life was most affected followed by social life, sleep, diet and health. In comparison, the greatest impairments were perceived for social life amongst those working permanent night shifts, followed by sleep, diet, health and domestic and family, respectively. However, an important point to bear in mind before attempting to interpret the findings is that the information was gained in different ways. During the interviews participants were presented with the problem domains and specifically asked to rank them in order of importance, thus ratings were purely subjective. No such instruction was given in the questionnaire study, where the information was gained objectively. This raises an important point in shiftwork research, that is, careful consideration must be given to the methods used in gaining information since the approach taken may affect the trends found.

Modifiers employed in the present work were those that had been proposed to be most consistently and powerfully linked with shiftwork outcomes. Dimensions were grouped according to their mediating impact on the outcome measures, as advocated within the literature and more precisely within the models of shiftwork tolerance. Thus modifiers were grouped under the headings, 'demographic', 'circadian/personality', and 'work related'. The direction of causation explored within the present chapter was based on a theoretical approach, using the rationale that demographic variables such as age can affect circadian/personality variables such as morningness or extroversion, and that together, demographic and circadian/personality variables could affect work related factors such as job satisfaction. Hence when taken together, the three groups could mediate an individual's ability to tolerate shiftwork. In the first instance, a statistically driven approach was taken, omitting any assumptions of the relative importance of the modifiers, whereby all modifiers were entered individually into a stepwise regression. Following this, a more theoretically driven model was derived, whereby the modifiers were grouped into blocks and entered individually to investigate their predictive power without the influence of covariates. However, since the main aim of the thesis was to investigate not just the simple linear pathways, but the multi-directional relationships between variables, the analysis was repeated, entering each block in turn in the order specified above, allowing an investigation of whether the predictive power was mediated once the effects of covariates had been partialled out.

When entered individually in stepwise analysis, results showed the number and predictive validity of modifiers to vary according to the outcome variable under investigation, although certain modifiers, such as LOC and general job satisfaction, were extracted for most, if not all, equations. Table 6.12 provides an overall summary of the trends found. Of these, externality was by far the stronger dimension, being the primary or secondary predictor in each of the 6 outcome measures. Further investigation showed that when broken down into its components, different subscales were important for different outcome measures. The greatest number of modifiers was extracted for psychological health and sleep, perhaps because this factor also contained the highest number of outcome variables (11 in total). An external LOC was the best overall predictor, with languidity, contract type, job satisfaction, extroversion and age all contributing decreasing, yet unique, proportions of the variance. Given that there was a high correlation between the two health outcomes, it is not surprising that externality and languidity also emerged as predictors of physical health. However, here languidity proved to be the stronger of the two.

Table 6.12. Summary of trends in stepwise regression†‡ amongst production line workers

Psychological health & sleep	Physical health	Social & domestic disruption	Perceived advantages of shiftwork	Dietary behaviour	Preference for daywork
Externality	Languidity	Externality	Low job sat.	Evening type	Low job sat.
Languidity	Externality	Low job sat.	Externality	Externality	Externality
Temp. contract	High job demand		Live near to site		Male
Low job sat.					Greater experience
Introversion					
Increasing age					

† predictors presented in order of importance in all cases
‡ reflects higher impairments in all outcome measures

Similarly, the strong correlation between social and domestic disruption, perceived advantages of shiftwork, and a preference for daywork was reflected by a similar pattern of modifiers. Whilst all 3 contained externality and low job satisfaction, for social and domestic disruption the former was the most important, whereas for the two attitude measures, the latter predicted a higher proportion of the variance. Finally, in keeping with the results so far, dietary behaviour was also found to be associated with an external LOC. However here, eveningness was a stronger predictor of the frequency of meals and whether they were perceived as being balanced and nutritious.

Preliminary findings from the statistical approach were generally supported in the theory driven hierarchical models, although this was not always the case. For example as shown in Table 6.13, when modifier variables were entered individually in their respective categories, a similar pattern emerged for psychological health and sleep, physical health, social and domestic disruption, dietary behaviour and a preference for daywork. Here the circadian/personality category was the most important, followed by work related, with demographic modifier variables being the weakest overall. In contrast, work related variables were the strongest predictors of the perceived advantages of shiftwork, although here, demographic variables were the weakest category overall. Despite this, the trends fitted well with the stepwise analysis.

Table 6.13. Summary of trends in hierarchical regression (individual blocks)†‡ amongst production line workers

Psychological health & sleep	Physical health	Social & domestic disruption	Perceived advantages of shiftwork	Dietary behaviour	Preference for daywork
Circadian/Pers	Circadian/Pers	Circadian/Pers	Work related	Circadian/Pers	Circadian/Pers
Work related	Work related	Work related	Circadian/Pers	Work related	Work related
Demographic	Demographic	Demographic	Demographic	Demographic	Demographic

† predictors presented in order of importance in all cases
‡ reflects higher impairments in all outcome measures

No summary table is provided for hierarchical analysis, where categories were entered sequentially, since the results were strikingly similar. In terms of physical health and social and domestic disruption only the entry of circadian/personality variables in step 2 increased the predictive power of the model, thus suggesting that, for these outcome measures, demographic and circadian/personality modifiers were quite distinct in their predictive power. In contrast, the fact that work related variables in the final step failed to increase the power of the models suggests that their effects were mediated by modifiers within the former two categories. Thus in these instances the hypothesised direction of effects were only partially supported.

The hypothesis was challenged by the results of the perceived advantages of shiftwork, where the predictive power of the model was increased with the introduction of circadian/personality modifiers in step 2 and further with work related variables in step 3. Such a trend suggested that circadian modifiers were not mediated by those within the demographic category, and that the two together failed to mediate the strength of work related variables. This was also true of the preference for daywork, and psychological health and sleep, measures. The opposite was noted for dietary behaviour where both circadian/personality and work related modifiers were attenuated in their impact by the categories entered before them, fully supporting the initial predictions.

Regression analysis on the length of sleep at different points within the shift cycle elicited few modifier variables. Interestingly, where variables were extracted they showed no consistent pattern. Overall the greatest number of predictors was evident for sleep length before the first shift of the cycle, where for morning shifts, high job satisfaction, being a longer sleeper and having a tendency toward morningness, entered the equation, whilst for the late shift, only shiftwork experience was extracted. For those working permanent nights, age and placing more value on mornings were found. The importance of shift type was further underlined by the analysis of sleep length between successive rest days where, after age and time awareness, shift type contributed a unique proportion of the variance.

The overall weakness of modifiers in predicting the length of sleep was supported in hierarchical analysis where, when entered in individual blocks, very few significant equations resulted. Despite this, several trends were found. For example, circadian/personality variables were most important and work related variables the weakest for all equations, apart from those relating to the prediction of sleep length before and between successive late shifts. Here the order of importance was: demographic, circadian/personality and work related, from strongest through weakest. The only other deviation was seen for sleep length before the first morning shift where demographic, rather than work related variables, were the least important category overall.

Hierarchical analysis that entered blocks of categories sequentially, supported the hypothesised direction of effects in all cases, although unfortunately the amount of missing data for those working permanent nights meant that this stage of the analysis could not be performed.

The poor performance of modifiers in the prediction of sleep length at different points throughout the shift cycle suggests that the measure may be more strongly associated with outcome, rather than modifier, variables. Associations between sleep disturbance, fatigue and alertness with psychological health measures support such an assumption. Although not performed until now, correlations between sleep lengths at different points within the cycle and each of the outcome factors found that, where correlations reached significance, they were highest on psychological health and sleep, for early and late shifts, and on social and domestic disruption for night shifts.

Whilst the survey enabled a greater exploration of the outcomes and modifiers of shiftwork tolerance and the inter-relationships between the two, a number of methodological limitations affected their interpretability and generalisability. The most pertinent of these was that the questionnaire was employed within a cross-sectional paradigm, meaning that questions regarding cause and effect could not be addressed. This was perhaps most obvious in the analysis of outcomes by work pattern where the relative impact of shift type on outcome variables was examined. Despite the fact that no comparisons achieved significance, nightworkers were found to have better dietary habits and perceived shiftwork as having more advantages than disadvantages. In contrast they were found to have more psychological and physical health problems, and showed a greater impairment to sleep and social/domestic life compared to those working rotating shifts without nights. When presented with such findings it is very easy to make the error of thinking that characteristics inherent in the night shift pattern are responsible for the pattern of outcomes, yet the mediating impact of modifier variables should not be discounted. Analysis of the scores on these factors revealed a number of subtle differences between the groups. Nightworkers were found to have significantly more experience of the current shift, were more vigorous in their ability to overcome drowsiness and were more internal in attributing responsibility for their job performance. Without performing longitudinal research, the direction of causation (that is whether the differences in level of problems were due to the type of shift worked or subtle differences in individual characteristics of each group) cannot be established. Interestingly, despite the earlier findings of differences in the level of problems by shift type, the type of work pattern failed to show an association with any of the outcome variables (except sleep length between successive rest days). This suggested that trends held true regardless of shift type.

Another shortcoming was the fact that, because the present study aimed to validate the information gained from the interview stage, it focussed on one company, therefore limiting the generalisability of the findings to the shiftwork community as a whole. As suggested by the interviews, the company had a strong corporate culture that recognised the possible outcomes of shiftwork and provided organised events and facilities in an attempt to attenuate the negative effects. However, the shiftwork community can vary widely along an array of factors even where the same shift patterns are worked, from the type of work performed to the structure of management. Further validation needs to be conducted in a similar industry, using a similar population of individuals, working the same shift patterns, under the same conditions of work. Such constraints may help to explain why much of the shiftwork research remains theoretical.

Given that an additional aim of the present work was to "design a questionnaire for the collection of more structured data", a critical review of the survey used is important. From a methodological perspective the questionnaire contained measures that related to each of the problem domains identified in the interview stage. Standardised surveys such as the SSI and SOS were extremely helpful in providing a basis on which to work. However, several criticisms from respondents suggested that, from the shiftworker's point of view, the survey needed some improvements. The most common remark was in relation to the length and depth of the questionnaire, resulting in a number of respondents simply failing to complete it. Whilst it is important to gain as much information as possible it is essential to strike an even balance, since asking too little can leave questions unanswered whilst asking too much can lead to boredom or lack of time, both of which can result in an impoverished data set. A related problem was the formatting of the questionnaire with many participants commenting that circling the response options was 'boring' and 'taxing', given that these types of scales were used throughout the survey. Finally, the fact that this phase of the research was conducted in company time also raised some problems. Whilst this may have increased the potential number of people willing to participate in the study, the manner in which a number of individuals approached the questionnaire suggested that they used the study as an opportunity to have time away from work, taking little interest in completing the questionnaire as truthfully and thoroughly as possible. The implications for conclusions made on the basis of such responses are obvious.

The arrangement of measures may also have elicited a conditioned response in that problem domains were split under sub-headings, as the interview data had suggested. However, doing so may have encouraged participants to rate problems similarly, which in turn may have affected factor loadings. With hindsight the scales used in the questionnaire could have been arranged randomly so that they could be completed individually, rather than being based on the responses to similar measures under the same sub-heading.

In summary, despite a number of methodological weaknesses, the above findings support and therefore validate those from the interview stage of the research, showing that the outcomes of shiftwork can be successfully grouped into major problem domains and that interactions existed between some outcome variables but not others. Furthermore, whilst the relative impact of each of the outcomes showed the same pattern across shift type, when compared to the ranking data from the interviews there were slight variations. It was suggested that this could be accounted for by the differences in the way that the data was collected. Correlations between outcome variables were further reflected in regression analysis with associated outcomes yielding similar modifiers. Of the modifier variables explored LOC was by far the strongest, where externality was related to greater problems in all outcome factors. However, when broken down into its components, the relative importance of the subscales was found to be dependent on the outcome in question. Finally, in terms of the hypothesised direction of effects, the predicted sequence did not hold true for all outcome measures, being fully supported in some cases (dietary behaviour), partially supported in others (physical health, and social and domestic disruption) and challenged in others (perceived advantages of shiftwork, preference for daywork, and psychological health). This suggests that the sequence of modifiers are not only dependent on the type of outcome, but are also affected by the interactions between them, with a similar sequence emerging for outcomes that were highly correlated.

7

THE EFFECT OF SHIFT TYPE ON SHIFTWORK TOLERANCE

7.1. Introduction

In an attempt to validate the findings from the previous study and to further explore the relationships between outcomes and modifiers of shiftwork tolerance, analysis was performed on an existing data set that had been conducted as an audit of the shift systems used in the engineering industry. This was primarily concerned with establishing the range of work schedules in use for this particular population, and to allow a comparison between the extent to which these hours actually varied from those scheduled.

Characteristics of this data set enabled several of the criticisms of the previous study to be addressed. Firstly, the sample was large, with data being collected from a multitude of companies. The fact that the data were collected from a different industry was a second advantage. Whilst the previous survey had been conducted on workers involved in continuous process assembly tasks, here workers were involved in more highly skilled, safety-critical maintenance work that, in comparison, was more physically demanding. Hence, in the same vein as the process model of shiftwork tolerance (Barton *et al.*, 1995), relationships between outcomes and modifiers could be compared across industries. Secondly, the fact that the data incorporated a large variety of shift types meant that the relationships could also be compared across different working patterns, again echoing the later models of shiftwork tolerance. Finally, the present survey was much shorter than used in the previous chapter, but included a number of the same measures, in abridged form. This gave the opportunity to address the criticism regarding the length of the survey used.

In light of these features the main aims of the present study were to:

1. validate the findings of the previous study using a larger sample, from more than one company;
2. explore the relationships between outcomes and modifiers within a different industry;
3. explore the relationships between outcomes and modifiers across shift types;
4. assess whether a shorter questionnaire would elicit similar results.

7.2. Method

7.2.1. *Questionnaire Administration*

The study surveyed maintenance engineers working in a safety critical environment both inside and outside of the UK. The study was introduced to the potential population in a monthly newsletter sent to all workers 2 weeks before the questionnaires were administered. Questionnaires (see Appendix 7) were sent and returned via post to all British registered members of the profession.

7.2.2. *Participants*

Demographical details are shown in Tables 7.1a and 7.1b. Completed questionnaires were returned by 2180 engineers of the initial 10,000 (approximately) who received a survey, giving a response rate of 21.8% overall. However, 87 of these were excluded from further analysis: 12 of which were returned by retired engineers, and 75 of which did not complete their shift system details, leaving a total of 2093. When broken down further, completed questionnaires were returned from workers at 197 different companies, across 156 sites. Although over 100 different work patterns were found, for the purposes of analysis, these were grouped into 5 different categories, of which: (1) 32.44% worked rotating shifts involving nights; (2) 30.29% worked rotating shifts without nights; (3) 9.13% worked permanent nights; (4) 1.43% worked permanent afternoons; and (5) 26.71% worked permanent mornings. The following sections summarise the demographical details for each group separately.

7.2.2.1. *Rotating with Nights*

Of the 679 engineers who worked a rotating shift involving nightwork, the majority were male (99.26%) and based in the UK (94.85%). Mean age was 43.15 years (SD 9.74) with a range of 23 to 65 years. As expected this was reflected in the wide range of work and shiftwork experience. For example, the number of years spent as an engineer ranged from 2 to 47 ($\bar{x}$ 23.74; SD 9.89), whilst the number of years in the present job ranged from 6 months to 41 years ($\bar{x}$ 9.11; SD 8.27). In terms of shiftwork experience, the average was 17.57 years (SD 9.19; range 1-43 years), whilst the number of years spent working the present shift pattern was much less at 6.96 (SD 6.05; range 6 months-30 years). Of those sampled 96.46% had a high level of responsibility with 97.05% being directly employed by the company. Mean commuting time was 38.7 minutes (SD 25.12) although some took 5 minutes whilst others took up to 5 hours. Mean number of hours scheduled to work per week was 42.63 (SD 6.74; range 8-84), although the hours normally worked were higher at 46.13 (SD 8.53; range 20-90). By far the most common work pattern within this category was the '2D2N4R' schedule, accounting for 66.57% of those working a rotating shift with nightwork. The second most popular was '4D4R4N4R', accounting for 8.84% of the population.

Table 7.1a. Demographical details (mean, SD) by shift type

	Rotating with nights (n=679)		Rotating without nights (n=634)		Permanent nights (n=191)		Permanent afternoons (n=30)		Permanent mornings (n=559)	
	$\bar{x}$	(SD)	$\bar{x}$	(SD)	$\bar{x}$	(SD)	$\bar{x}$	(SD)	$\bar{x}$	(SD)
Age (yrs)	43.15	(9.74)	45.66	(9.90)	43.83	(10.29)	44.47	(10.71)	45.14	(10.48)
Engineering experience (yrs)	23.74	(9.89)	26.25	(9.93)	24.56	(10.07)	22.77	(10.62)	25.50	(10.76)
Present job experience (yrs)	9.11	(8.27)	12.81	(10.22)	9.90	(8.74)	8.27	(7.35)	7.79	(7.52)
Shiftwork experience (yrs)	17.57	(9.19)	20.51	(9.61)	17.73	(9.54)	16.91	(10.05)	16.44	(9.79)
Present shift experience (yrs)	6.96	(6.05)	6.71	(8.15)	6.35	(7.53)	2.09	(2.17)	4.82	(6.35)
Commuting time (mins)	38.70	(25.12)	33.79	(20.44)	36.71	(36.62)	34.22	(14.96)	36.58	(27.07)
Scheduled hrs/week	42.63	(6.74)	39.77	(5.07)	40.53	(7.25)	40.77	(5.12)	40.82	(7.06)
Actual hours/week	46.13	(8.53)	42.29	(6.35)	44.32	(8.21)	43.80	(7.63)	45.86	(9.26)

Table 7.1b. Demographical details (frequencies) by shift type

	Rotating with nights (n=679)		Rotating without nights (n=634)		Permanent nights (n=191)		Permanent afternoons (n=30)		Permanent mornings (n=559)	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Gender:										
Male	674	99.3	631	99.5	191	100.0	30	100.0	551	98.6
Female	5	0.7	2	0.3	0	-	0	-	8	1.4
Level of responsibility:										
High	655	96.5	590	93.1	176	92.1	27	90.0	484	86.6
Low	18	2.7	40	6.3	13	6.8	3	10.0	67	12.0
Contract type:										
Employed directly	659	97.1	618	97.5	180	94.2	28	93.3	519	92.8
Contracted	16	2.4	14	2.2	8	4.2	2	6.7	35	6.3
Country of work:										
UK	644	94.8	605	95.4	185	96.9	30	100.0	540	96.6
Outside UK	26	3.8	28	4.4	6	3.1	0	-	15	2.7

7.2.2.2. Rotating without Nights

As with the previous group, of the 634 engineers who worked a rotating shift without nights, the majority were male (99.5%) and based in the UK (95.4%). Mean age was 45.66 years (SD 9.90) with a range from 17-65. The number of years spent as an engineer averaged at 26.25 (SD 9.93; range 5-50), whilst the number of years in the present job averaged at 12.81 (SD 10.22, range .5-43). Shiftwork experience varied from 6 months through to 47 years ($\bar{x}$ 20.51; SD 9.61), whilst the number of years spent working the present shift pattern showed similar results with a range of 6 months-40 years, but a lower mean of 6.71 years (SD 8.15). Of those sampled 93.1% had a high level of responsibility with 97.5% being directly employed by the company. Mean commuting time amongst this group was 33.6 minutes (SD 20.4; range 5 mins-3h).

In terms of work patterns, the mean number of hours scheduled to work per week was 39.77 (SD 5.07; range 20-64), although the hours normally worked were higher at 42.29 (SD 6.35; range 24-70). The shift system worked by the largest number of engineers within this sample was a '7M4R7A3R' schedule (22.7%), although this was closely followed by the '3M4A3R4M3A4R' pattern (18.61%).

7.2.2.3. Permanent Nights

Of the 191 engineers who worked a permanent night shift, all were male, with 96.9% based in the UK. Mean age was 43.83 years (SD 10.29) with a range from 23-68. The number of years spent as an engineer averaged at 24.56 (SD 10.07; range 5-48), whilst the number of years in the present job averaged at 9.90 (SD 8.74, range 6 months-44y). Shiftwork experience varied from 1 to 44 years ($\bar{x}$ 17.73; SD 9.54), whilst the number of years spent working the present shift pattern ranged between 6 months-36 years, with a mean of 6.35 (SD 7.53). Of those sampled 92.1% had a high level of responsibility with 94.2% being directly employed by the company. Mean commuting time amongst this group was 36.71 minutes (SD 36.62; range 5mins-7h).

In terms of work patterns, scheduled work hours averaged at 40.53 (SD 7.25; range 12-84), although, as with previous groups, the hours normally worked were higher at 44.32 (SD 8.21; range 30-80). The most popular shift system within this sample was a '4N4R' schedule (36.1%), although the alternative '4N3R' schedule was worked by a comparative number (27.7%). The only other prominent pattern within this category was a '7N4R7N3R' schedule worked by 16.2%.

7.2.2.4. Permanent Afternoons

The smallest cohort, only 30 engineers working permanent afternoons returned a survey. Amongst these all were male and based in the UK. Mean age was 44.47 years (SD 10.71) but ranged from 21-65. The number of years spent as an engineer averaged at 22.77 (SD 10.62; range 3.5-46), whilst the number of years in the present job averaged at 8.27 (SD 7.35, range .5-25). Shiftwork experience varied from 0.5-37 years ($\bar{x}$ 16.91; SD 10.05), whilst the number of years spent working the present shift pattern was much lower at just 2.09 (SD2.17; range 6months-11y). Of those sampled 90% had a high level of responsibility with 93.3% being directly employed by the company. Mean commuting time amongst this group was 34.22 minutes (SD 14.96; range 10mins-1h 10 mins).

In terms of work patterns, scheduled work hours averaged at 40.77 (SD 5.12; range 37-60), although, as with previous groups, the hours normally worked were higher at 43.80 (SD 7.63; range 16-60). The shift system worked by the largest number of participants within this category was a '4A4R' schedule (11.1%). However, other patterns such as '6A4R4A6R4A4R' (10.3%) and '4A4R7A4R' (3.4%) were also noted.

7.2.2.5. Permanent Mornings

Of the 559 engineers who worked a permanent morning shift, 98.6% were male, with 96.6% based in the UK. Mean age was 45.14 years (SD 10.48; range 21-67). The number of years spent as an engineer averaged at 25.50 (SD 10.76; range 6 months-50y), whilst the number of years in the present job averaged at 7.79 (SD 7.52, range 6months-40y). Shiftwork experience varied from .5 to 50 years ($\bar{x}$ 16.44; SD 9.79), whilst the number of years spent working the present shift pattern ranged between 6 months-48 years, with a mean of 4.82 (SD 6.35). Of those sampled 86.6% had a high level of responsibility with 92.8% being directly employed by the company. Mean commuting time amongst this group was 36.28 minutes (SD 27.07; range 4.8 mins-4.5h).

In terms of work patterns, scheduled work hours averaged at 40.82 (SD 7.06; range 8-96), although, in line with previous groups, the hours normally worked were higher at 45.86 (SD 9.26; range 3-84). By far the most common work pattern within this category was the '5D2R' schedule, accounting for 51.9% of those working permanent mornings. The second most popular was '4D4R', accounting for 27.7% of the population.

7.2.2.6. Comparison of Groups

Table 7.2 shows a summary of the group comparisons. Comparisons between the 5 shift types on the demographic variables showed that the groups differed on age ($F_{(4,2080)}$=5.901, p<.001) where those working rotating shifts with nights were significantly younger than those working permanent mornings or rotating shifts without nights. A similar trend also appeared in the number of years spent in engineering, where those working rotating shifts with nights had been involved for less time than those working permanent mornings or rotating shifts without nights ($F_{(4,2018)}=5.584$, $p<.001$).

In terms of the experience of the present job, most groups, apart from permanent afternoon workers, significantly differed from one another ($F_{(4,2004)}=26.064$, $p<.001$) with rotating shifts without nights being the longest, and permanent mornings being the shortest. Similarly, for shiftwork experience, those working rotating shifts without nights had the longest experience, whilst permanent morning workers had the least. Here all groups, with the exception of permanent afternoon workers, had significantly less experience ($F_{(4,1910)}=13.671$, $p<.001$).

Table 7.2. ANOVA summary of group comparisons

	F	df	sig
Age (yrs)	5.901	4,2080	.000
Engineering experience (yrs)	5.584	4,2018	.000
Present job experience (yrs)	26.064	4,2004	.000
Shiftwork experience (yrs)	13.671	4,1910	.000
Present shift experience(yrs)	9.995	4,1945	.000
Commuting time (mins)	3.011	4,2002	.017
Schedules hours/week	15.730	4,1919	.000
Actual hours/week	19.783	4,1836	.000

As can be seen in Table 7.1a, both permanent morning and afternoon shiftworkers had less experience of their present shift pattern than those working permanent nights or rotating shifts ($F_{(4,1945)}=9.995$, $p<.001$). This was supported in *post hoc* comparisons where experience of the morning shift was significantly less than rotating shifts, whilst those working permanent afternoons had significantly less experience than those working permanent nights or either of the rotating shift patterns. Only the two rotating shift categories showed a significant difference in commuting time ($F_{(4,2002)}=3.011$, $p<.05$), where those involved in nights travelled for an average of 5 minutes longer than those who did not work nights as part of their shift pattern.

In terms of scheduled work hours all groups, with the exception of afternoon workers, significantly differed from those working rotating shifts with nights ($F_{(4,1919)}=15.730$, $p<.001$), who worked the highest number of hours. However, permanent morning shiftworkers also differed from those working rotating shifts without nights. For actual work hours ($F_{(4,1836)}=19.783$, $p<.001$), all groups, with the exception of permanent afternoons, significantly differed from those working rotating shifts without nights. In both cases the latter worked fewest hours. Chi-square analysis revealed a significant association between shift type and gender ($\chi^2=4.70$, $p>.05$), and whether the work was UK based ($\chi^2=2.73$, $p>.05$).

7.2.3. Materials

7.2.3.1. Moderator Variables

Demographic

Variables within this category included date of birth, gender, respondents' level of responsibility, contract type, working inside or outside of the UK, company and place of work, number of years: spent as an engineer, in the present job, on the present shift system, shiftwork experience; and commuting time. Also included under this heading were characteristics of the shift system worked, such as the number of hours worked per week, the length of different shift types and the start and finish times of the shifts.

Circadian

In the present survey two variables measuring circadian phase (morningness), and circadian type (flexibility/rigidity) were included as single item questions. For the former the participants were asked "Are you the sort of person who feels at their best early in the morning, and who tends to feel tired earlier in the evening?", whilst in the latter the question read "Are you the sort of person who finds it very easy to sleep at unusual times or in unusual places?". Each item was scored on a 9 point Likert scale with response options ranging from 1='definitely not' to 9='definitely yes'.

Work-Related

Work related variables contained in the survey were the two items relating to (1) control over the shifts worked and (2) control over the start and finish times of the shifts worked, as used in the previous study. Responses were scored on a 5 point Likert scale with options ranging from 1='None' to 5='Complete'.

7.2.3.2. Outcome Variables

Attitudes toward Shiftwork

Respondents' attitude towards shiftwork was assessed by the single item asking whether the advantages of shiftwork outweighed the disadvantages. As with previous scales, responses were scored on a 9 point Likert scale with options ranging from 1='definitely not' to 9='definitely yes'.

Sleep and Alertness

In terms of sleep, respondents were asked to indicate the number of hours sleep they obtained between each of the successive shift types included in their work pattern. For alertness, respondents were asked "On average, how alert or sleepy do you feel" during each of the shift types included in their work pattern. Scoring was based on a 9 point Likert scale with response options ranging from 1='very alert' to 9='very sleepy (fighting sleep)'.

Risk

Assessment of the perceived risk attributed to each type of shift was measured by two items. Using a 9 point Likert scale with response options ranging from 1='Very unlikely' through to 9='Very likely', in the first respondents were asked "On average, how likely do you think you are to make a minor mistake" for early, late or night shifts as appropriate. The second item asked respondents "On average, how confident are you that you can drive home safely" after each of the shift types worked. Here, as before, a 9 point Likert scale was used for scoring, although in this case, response options ranged from 9='Very confident' through to 9='Very unconfident'.

Physical Health

Physical health was assessed through a reduced 4 item version of the Physical Health Questionnaire, as used in the previous study. Here, items were collapsed into 4 questions, each relating to the main health areas covered by the survey: gastrointestinal, cardiovascular, minor infections and musculoskeletal pain. Items were scored on a 9 point Likert scale with response options ranging from 1='Almost never' to 9='Almost always'.

Social and Domestic Interference

Analysis of the outcome measures used in Chapter 6 found the three item measure relating to interference with social, domestic, and non-domestic activities to produce a reliable factor structure, and in the present study, the three items were subsumed into a single item. Here respondents were asked "How much does your work schedule interfere with your leisure activities, family life, and non-leisure activities?". Scoring was based on a 9 point Likert scale with response options ranging from 1='Not at all' to 9='Very much'.

7.3. Results

7.3.1. Statistical Analysis

In the first instance, scores derived from the outcome measures were analysed by shift type, in order to assess the relative impact of different shift categories on the measures used as indicators of tolerance to shiftwork. Regression analyses were then performed to investigate the predictive power of the modifier variables with the influence of covariates both uncontrolled and controlled, using the same strategy as the previous chapter. However, due to the large number of variables derived from the questionnaires, both outcome and modifiers variables were first subjected to correlational and/or factor analysis. The following sections discuss the rationale behind doing so and the findings that resulted.

7.3.1.1. Reduction of Outcome Variables

All outcome variables were subjected to exploratory factor analysis in an effort to reduce their total number, in addition to attempting to derive underlying dimensions within groups of variables. From the 19 variables entered, Principal Components Analysis with Varimax rotation extracted 6 factors with eigenvalues greater than 1, which between them, accounted for 69.04% of the total variance.

With loadings ranging from .657 to .765, Factor 1 accounted for 12.82% of the variance and contained the 4 reduced physical health items. Reliability analysis resulted in a total scale alpha of .7195, with no single item reducing overall reliability. Thus, the 4 item structure was retained and named 'Physical Health'.

Factors 2, 3, and 4 showed a common structure, being composed in each case of 3 items relating to on-shift alertness, the likelihood of making a minor mistake at work and confidence in driving home following work, with each factor relating to a different shift type. Factor 2, relating to the night shift, accounted for the highest percentage of explained variance of the three shift types, at 12.69% and contained factor loadings from .727 to .819. Factor 3 contained loadings ranging from .675 to .835 and accounted for 11.97% of the variance. All items within this factor related to the morning shift. Finally, the structure derived for the afternoon shift (Factor 4) explained 11.16% of the total variance and contained loadings ranging from .770 to .795. Reliability analysis found acceptable alpha coefficients on each of the three factors, with the night shift being the most reliable at .7975, followed by the morning shift at .7708, and the afternoon shift the lowest at .7571. In all cases no single item reduced the overall scale reliability. Therefore, all three factor structures were retained and will be referred to from here on in as "Alertness and Safety".

Factor 5 combined the 4 items relating to the number of hours sleep between morning, afternoon, and night shifts in addition to the amount of sleep gained during rest days. Despite the fact that the structure contained loadings ranging from .583 through to .807, accounted for 11.84% of the explained variance, and had a total scale alpha of .7306, because a clear structure had appeared between shift types with regard to alertness and safety, each of the component items in this case were also kept separate in further analysis. This also allowed a comparison with the previous chapter.

Finally, Factor 6 contained the single items relating to social and domestic disruption and attitudes towards shiftwork. Although factor loadings were high at .878 and .715 respectively, accounted for 8.57% of the total variance, and yielded a total scale alpha of .6925, they were kept as separate dimensions in further analysis to allow comparison with the results of previous studies.

The strength of association amongst outcome variables was further explored by correlating the five factors against one another. The results are summarised in Table 7.3. From this it is evident that the associations with physical health were wide ranging, correlating with all outcome measures except sleep length between successive rest days. Here reporting of more physical health symptoms was associated with greater perceived risk, a less positive attitude towards shiftwork, greater impairment to social and domestic life and less sleep during work days.

In terms of alertness and safety, a consistent pattern also emerged. In addition to being negatively related to attitudes towards shiftwork and positively to social and domestic interference, each alertness and safety measure also negatively correlated with its appropriate sleep length, with the strongest relationship occurring between night shift measures ($r_{(932)}$=-.306, $p<.001$). In all cases, greater concerns about alertness and safety were associated with less sleep.

In support of the previous chapter, the strongest correlation of all outcomes was that between advantages of shiftwork and social and domestic interference, where $r_{(2025)}$=-.536 ($p<.001$) showed that those with greater impairments to their social and family lives also had a less positive attitude towards shiftwork. Interestingly, the pattern of results also showed these two variables to correlate with only two of the four sleep lengths included in the analysis where, again, the strongest relationships occurred in conjunction with night shift sleep. As expected, all sleep length measures correlated with one another, with positive relationships in all cases suggesting that a longer sleep on one shift was related to longer sleep during other shift types, and during rest days.

7.3.1.2. Reduction of Modifier Variables

Although the problems incurred in previous studies (where the ratio of moderator variables to participants within the sample posed a problem when using regression analysis) was not a concern with the large data set in the present study, it was still important to analyse the modifier variables for collinearity. Therefore, as before, relationships between modifiers were examined through Pearson's correlations.

Table 7.3. Correlations between outcome variables (n=2180) amongst maintenance engineers

	Physical health	Alertness & Safety			Advantages of shiftwork	Social & domestic interference	Sleep length			
		Morning	Afternoon	Night			Morning	Afternoon	Night	Rest Day
Physical Health	-									
Alertness & Safety										
Morning	.351 ***	-								
Afternoon	.348 ***	.401***	-							
Night	.402 ***	.276 ***	.366 ***	-						
Advantages of shiftwork	-.328***	-.345 ***	-.248 ***	-.327 ***	-					
Social & domestic interference	.300***	.288 ***	.222 ***	.261 ***	-.536 ***	-				
Sleep length										
Morning	-.164***	-.251 ***	-.052	-.059	.100 ***	-.049 *	-			
Afternoon	-.141 ***	-.022	-.155***	-.082	.008	-.019	.432 ***	-		
Night	-.184 ***	.045	-.133	-.306 ***	.186 ***	-.100 **	.397 ***	.610 ***	-	
Rest Day	-.024	.017	-.026	-.054	-.019	.018	.282 ***	.529 ***	.264***	-

*** p<.001; ** p<.01; * p<.05

Although a number of the variables were significantly correlated, very few showed correlations over .40. Amongst the demographic variables, a strong relationship between 'age' and 'number of years shiftwork experience' was found ($r_{(1965)}$=.702, p<.001) and between 'age' and the 'number of years spent as an engineer' ($r_{(2078)}$=.902, p<.001), leading to the retention of age only. In terms of the work related variables a strong relationship also existed between 'control over the specific shifts worked' and 'control over the specific start and finish times of the shifts worked' ($r_{(2110)}$=.712, p<.001). Thus, scores on both were z-standardised and summed to give a global 'control' measure (α=.8318).

It was originally intended that the shift characteristics (e.g. start and finish times, number of shifts worked before a break, number of days worked before a changeover), which formed a large part of the questionnaire, would be used as independent variables in further analysis, since a variety of shift systems were worked under each of the 5 groups. However, exploratory analysis showed substantial amounts of missing data on a number of variables, which in some cases reduced the number of cases being entered into the regressions from a potential 679 to just 69, excluding over 90% of the sample. Thus, for this reason shift characteristics were not included as independent variables in further analysis. Despite this, because 'shift length' was felt to be an important modifier variable for inclusion in the regression models, with the large variation in shift length within each shift category, this was included. Table 7.4 shows the remaining variables used in the analysis.

Table 7.4. Modifier variables used in further analysis

Demographic	Circadian	Work related
Age	Circadian phase	Control over shifts
Gender	Circadian type	
Contract type		
Level of responsibility		
Work in the UK		
Engineering experience (yrs)		
Present job experience (yrs)		
Present shift experience (yrs)		
Commuting time (mins)		
Scheduled hours/week		
Shift length (hrs)		

It was also noted that the largest proportion of missing data occurred amongst responses from those working rotating shifts with nights, and especially on items relating to afternoon shifts. Inspection of the range of shift systems worked under the umbrella term of 'rotating shifts with nights' showed that only 5 participants worked a 3-shift pattern including afternoon shifts, therefore these 5 participants were excluded from regression analysis. Indeed, exclusion of these alone increased the number of cases being included in the regressions from 61 to 596.

Furthermore, due to the small number of participants within the permanent afternoons group (30) those involved in this pattern were also excluded from further analysis.

7.3.1.3. Differences between Groups

In order to assess the relative impact of shift type on outcome measures, differences between the groups were examined. Descriptive statistics for each of the 5 outcome measures are shown in Table 7.5.

Table 7.5. Descriptive statistics for each outcome by shift type

	$\bar{x}$	(SD)	F or t
Attitudes toward Shiftwork			
Rotating with nights	6.12	(2.35)	
Rotating without nights	4.82	(2.62)	
Permanent nights	5.62	(2.53)	
Permanent mornings	5.85	(2.45)	$F_{(3,2028)}=32.726$ ***
Social & Domestic Disruption			
Rotating with nights	5.11	(2.47)	
Rotating without nights	5.94	(2.45)	
Permanent nights	5.69	(2.47)	
Permanent mornings	5.84	(2.56)	$F_{(3,2047)}=12.907$ ***
Physical Health†			
Rotating with nights	0.03	(2.95)	
Rotating without nights	0.36	(2.96)	
Permanent nights	0.26	(3.04)	
Permanent mornings	-0.50	(2.85)	$F_{(3,2050)}=9.043$ ***
Alertness & Safety – M†			
Rotating with nights	-0.52	(2.04)	
Rotating without nights	0.97	(2.83)	
Permanent mornings	-0.49	(2.18)	$F_{(2,1825)}=79.380$ ***
Alertness & Safety – A†			
Rotating without nights	0.05	(2.404)	-
Alertness & Safety – N†			
Rotating with nights	0.16	(2.40)	
Permanent nights	-1.32	(2.28)	$t_{(836)}=7.312$ ***
Sleep Length – M			
Rotating with nights	6.80	(1.12)	
Rotating without nights	6.63	(1.11)	
Permanent mornings	7.08	(1.00)	$F_{(2,1744)}=23.533$ ***
Sleep Length – N			
Rotating with nights	6.47	(1.40)	
Permanent nights	6.70	(1.11)	$t_{(821)}=2.263$ *
Sleep Length – Rest Day			
Rotating with nights	8.00	(1.15)	
Rotating without nights	8.01	(1.04)	
Permanent nights	8.06	(1.35)	
Permanent mornings	7.97	(1.53)	$F_{(3,1755)}=0.242$

*** $p<.001$; ** $p<.01$; * $p<.05$;
† Factor score derived through z transformation of component items

In terms of attitudes towards shiftwork, those working rotating shifts with nights had the most favourable attitude, although permanent morning workers were only slightly less positive. The least favourable attitude was held by those working rotating shifts without nights. Analysis of variance found a significant difference between groups ($F_{(3,2028)}=32.726$, $p<.001$), with all feeling that the advantages of shiftwork outweighed the disadvantages to a greater extent than the rotating without nights group.

Responses on the physical health measure found those working rotating shifts without nights to experience more health problems. Again, analysis of variance found a significant difference between groups ($F_{(3,2050)}=9.043$, $p<.001$) with all groups experiencing significantly more problems than those working permanent morning shifts. When broken down into its constituent components, results showed that of the four subscales, all shift types experienced musculoskeletal pain most often (overall mean 4.72; SD 2.33), possibly due to the physical nature of the work being performed, and cardiovascular complaints least often (overall mean 2.35; SD 1.84). Further analysis showed the difference to be mainly due to those working rotating shifts without nightwork, who experienced most problems on all but the minor infections subscale. Those working permanent mornings experienced the fewest problems on all 4 physical health measures. *Post hoc* comparisons confirmed these findings where, for gastrointestinal symptoms, those working rotating shifts experienced significantly more symptoms than those working permanent mornings, whilst for minor infections all groups significantly differed from those employed on permanent mornings. In terms of musculoskeletal pain, only the difference between rotating without nights and permanent mornings reached significance.

Likewise, for social and domestic disruption those working rotating shifts with nights experienced fewest problems, whilst those working rotating shifts without nights experienced most. Analysis of variance found a significant difference between groups ($F_{(3,2407)}=12.907$, $p<.001$) with *post hoc* comparisons identifying significant differences between those working rotating shifts without nights with both the permanent mornings and rotating with nights groups, and between those working permanent nights and rotating shifts involving nights.

In terms of alertness and safety during the morning shift, analysis of variance revealed a significant difference between groups, with those working rotating shifts without nights being more sleepy and less confident in their safety than those working rotating shifts with nights or permanent mornings ($F_{(2,1825)}=79.380$, $p<.001$). For alertness and safety during the night shift, the rotating with nights group experienced more problems than those working permanent nights ($t_{(836)}=7.312$, $p<.001$).

Finally, a significant difference between groups on sleep length during periods of morning work was found ($F_{(2,1744)}=23.533$, $p<.001$), with those working permanent mornings obtaining significantly more than the rotating groups. However, of the rotating groups, those involved in nightwork obtained significantly more. For sleep length during periods of nightwork, permanent nightworkers obtained significantly more than the rotating with nights group ($t_{(821)}=2.263$, $p<.05$). However, in contrast all 4 shift categories obtained around 8h of sleep during rest days, with the slight differences between groups not reaching significance ($F_{(3,1755)}=0.242$, $p>.05$).

Taken together, the findings suggest that those working rotating shifts without nights experienced the highest number of physical health problems, the greatest social and domestic disruption, less alertness and safety during the morning shift, and less sleep during the morning shift, and had the least favourable attitude towards shiftwork. Those working rotating shifts with nights, on the other hand, had the most favourable attitude, the least social and domestic disruption and the second lowest physical health complaints. Of the permanent shifts, morning workers had the longest sleep length during work days, and the fewest physical health complaints, but suffered a high amount of social and domestic disruption. Despite this, they still maintained a favourable attitude towards shiftwork.

In order to assess whether the trends found could be linked to variations in the individual characteristics of the four groups, scores on all modifiers were compared across shift type. Findings showed the groups to significantly differ on all but gender and whether the job was UK based or not. In terms of age, both the permanent morning and rotating without nights group were significantly older than those working rotating shifts with nights ($F_{(3, 2045)}=8.194$, $p<.001$). Similarly, the highest level of responsibility was evident for those in the rotating with nights group, being significantly higher than those in either the permanent mornings and rotating without nights groups, the latter of which significantly differed themselves ($F_{(3,2038)}=15.239$, $p<.001$). The permanent morning group comprised significantly more contracted personnel than those in either of the rotating groups ($F_{(3, 2043)}=6.207$, $p<.001$).

In terms of experience, those working rotating shifts with nights had been working in the industry for the longest time significantly more than either the permanent morning or rotating without nights groups ($F_{(3, 1985)}=7.331$, $p<.001$). Moreover, the rotating groups had the longest experience of their present shift system, although this was only significantly more than permanent morning workers ($F_{(3, 1913)}=10.044$, $p<.001$). Similarly, those working permanent mornings also had the least experience of their present job, differing from all other groups ($F_{(3, 1971)}=34.113$, $p<.001$). However, those working rotating shifts without nightwork had the most experience, differing from both the permanent night and rotating with nights groups.

Commuting time showed very few differences with only the rotating groups differing from one another. Here those involved in rotating shifts without nights had the shortest commute of all groups ($F_{(3, 1969)}$=3.992, p<.01). In terms of scheduled work hours, rotating with nights worked the most, whilst those involved in rotating shifts without nightwork worked the fewest. Permanent groups worked similar amounts. Here permanent mornings worked significantly fewer than those on rotating shifts, whilst both permanent nights and rotating shifts without nights groups worked significantly fewer than rotating workers with nights ($F_{(3, 1887)}$=20.668, p<.001).

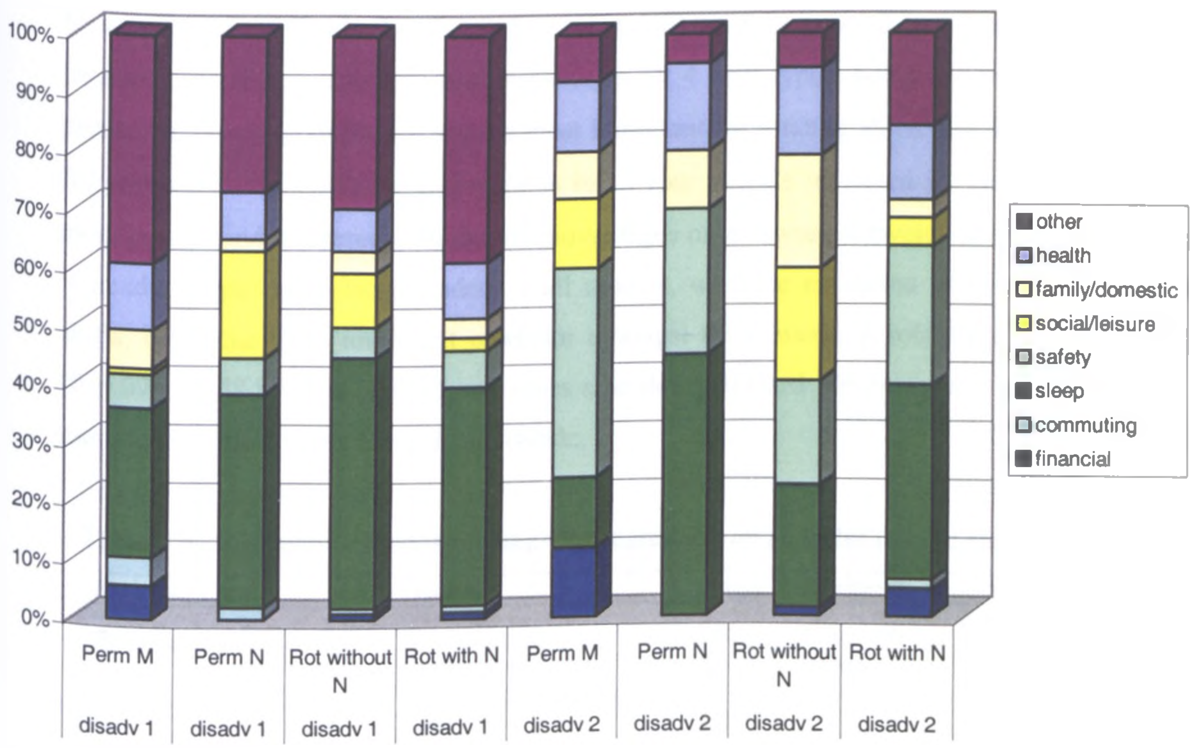
In terms of the circadian modifiers, rotating without nights were found to have a stronger tendency toward eveningness, whilst the permanent mornings group tended toward morningness, possibly a reflection of a self-selected sample. Here, all groups reported fewer E-type tendencies than permanent nightworkers ($F_{(3, 2045)}$=11.107, p<.001). As well as tending toward eveningness, permanent nightworkers were also found to exhibit the most flexibility in terms of their sleeping habits ($F_{(3, 2047)}$=14.344, p<.001). Finally, the only work related modifier to be included in the analysis was control, where greater control over the shifts worked and the start and finish times of the shift worked was shown by those working permanent mornings ($F_{(3, 2044)}$=78.378, p<.001).

Perceived Disadvantages of Shiftwork

In order to examine the perceived disadvantages of shiftwork in a manner uncontaminated by the specific wording of questions, respondents were given the opportunity to make comments freely at the end of the survey. These responses were classified into major domains, according to the first and second mentioned, with no attempt to match outcome variables employed in the survey. The findings are illustrated in Figure 7.1.

Similar to the previous chapter, all respondents, regardless of shift type, reported sleep as a major disadvantage of their work pattern, although this was strongest amongst those working rotating shifts without nightwork, and least amongst those working permanent mornings. Similarly, comments classified in the 'other' category, consisting of shift characteristics, workload and work environment, were also widely reported, being the second most important disadvantage across the sample. Although permanent nightworkers reported effects of shiftwork on social and leisure activities, compared to Chapter 6, comments of this nature were low. Concerns regarding safety at work were reported by a comparable proportion of respondents from each shift group.

Figure 7.1. Perceived disadvantages by shift type amongst maintenance engineers



Different trends were evident in relation to the secondary disadvantages. Whilst problems with sleep and fatigue remained dominant amongst those working nights as part of their shift system, concerns about safety rose in all 4 groups, being the strongest amongst those working permanent mornings. Disadvantages related to domestic and family life were also comparatively higher.

7.3.1.4. Multivariate Analysis

In order to examine the predictive validity of the modifier variables, a series of regression analyses were performed, where modifiers were treated as independent variables with each of the outcome variables being entered in turn as the dependent variables. Following the same strategy as the previous study, in the first instance, a statistically driven model was derived for each of the outcome variables whereby all modifiers were entered together in a stepwise method. Following this a theoretically driven model was derived, using the modifiers as blocks of related predictors. As before, in order to investigate the predictive power of each category of modifiers without the influence of covariates, each block was entered on its own. These results were then compared when the 3 blocks were entered into the regression model sequentially, in the order: demographic, circadian, work related. Separate regression analyses were performed for each of the 4 shift categories. The following section summarises the results of this analysis.

Stepwise Regression Analysis

Attitudes toward Shiftwork

It is evident from Table 7.6 that, when all modifiers were entered in a stepwise regression, 'control over shifts' emerged as a predictor in all 4 shift types, being the most important for permanent morning shifts, the second most important for rotating shifts and the least important for permanent nights. Positive β-weights in all four models indicated an association between more control and the perception that the advantages of shiftwork outweighed the disadvantages. 'Circadian type' was also included in all models, with the exception of permanent morning shifts, being the most important predictor amongst those working rotating shifts with nights (R^2=.076, F=48.803, p<.001). In all cases a tendency toward flexibility was associated with a more favourable attitude towards shiftwork.

Table 7.6. Summary statistics for stepwise regression on attitudes toward shiftwork

Shift category	Predictors	R^2 change	F change	df	β
Rotating with nights	Circadian type	.076	48.803 ***	1,596	.257 ***
	Control over shifts	.016	10.468 ***	1,595	.135 **
	Present shift experience	.007	4.763 *	1,594	.085 *
	Total	***9.9%***			
Rotating without nights	Present shift experience	.066	37.705 ***	1,532	.286 ***
	Control over shifts	.043	25.563 ***	1,531	.203 ***
	Length of A shifts	.041	25.292 ***	1,530	.203 ***
	Circadian type	.012	7.580 **	1,529	.110 **
	Total	***16.2%***			
Permanent nights	Commuting time	.045	6.920 **	1,146	-.219 **
	Circadian type	.047	7.507 **	1,145	.197 *
	Control over shifts	.035	5.782 *	1,144	.188 *
	Total	***12.7%***			
Permanent mornings/days	Control over shifts	.053	22.762 ***	1,404	.232 ***
	Commuting time	.017	7.446 **	1,403	-.131 **
	Total	***7.0%***			

*** p<.001; ** p<.01; * p<.05

'Commuting time' was also a common predictor amongst those involved in permanent shifts. For example, commuting time was the most important predictor amongst permanent nightworkers (R^2=.045, F=6.920, p<.01), whilst for those involved in permanent mornings, commuting time predicted 1.7% (F=7.446, p<.01). A negative relationship in both cases suggested that as commuting time increased, respondents' attitudes towards shiftwork became more negative. Whilst commuting time was important for groups involved in permanent shifts, 'present shift experience' emerged as a predictor for rotating groups, being the most important amongst those involved in nightwork (R^2=0.66, F=37.705, p<.001). In both cases positive β-values suggested that greater experience of the present shift system was associated with the feeling that the advantages of shiftwork outweighed the disadvantages.

Additional predictor variables were also found for the rotating shifts without nights group, where the 'length of afternoon shifts' accounted for a further 4.1% of the total variance (F change=25.292, p<.001). Here β=.203 (p<.001) indicated that longer shifts evoked a more positive attitude. Overall, the model derived for rotating shifts without nights accounted for the highest proportion of variance in attitudes towards shiftwork (16.2%), although this was closely followed by the permanent nights category (12.7%).

Social & Domestic Disruption

As with physical health, 'circadian type' emerged as the most important predictor for shift categories involving nightwork, and indeed was the only predictor in the case of permanent nightshifts (see Table 7.7, below). Negative β-weights in both cases suggested that flexibility was associated with less disruption. However, the most common predictor overall was 'present shift experience', extracted for 3 of the 4 shift categories, being the most important for rotating without nights (R^2=.033, F=18.153, p<.001) and the second most important for those working permanent mornings (R^2=.023, F=9.982, p<.01). As with circadian type, negative β-weights suggested that those with greater experience suffered less social and domestic interference.

Table 7.7. Summary statistics for stepwise regression on social & domestic disruption

Shift category	Predictors	R^2 change	F change	df	β
Rotating with nights	Circadian type	.022	13.547 ***	1,596	-.158 ***
	Contract type	.017	10.809 ***	1,595	.128 ***
	Present shift experience	.006	3.928 *	1,594	-.080 *
	Total	***4.5%***			
Rotating without nights	Present shift experience	.033	18.153 ***	1,532	-.161 ***
	Control over shifts	.023	13.121 ***	1,531	-.153 ***
	Age	.007	3.898 *	1,530	-.088 *
	Total	***6.3%***			
Permanent nights	Circadian type	.031	4.712 *	1,146	-.177 *
	Total	***3.1%***			
Permanent mornings/days	Commuting time	.029	12.113 ***	1,404	.144 **
	Present shift experience	.023	9.982 **	1,403	-.129 **
	Contract type	.016	7.003 **	1,402	.141 **
	Control over shifts	.012	5.317 *	1,401	-.106 *
	Level of responsibility	.009	3.952 *	1,400	-.095 *
	Total	***8.9%***			

*** p<.001; ** p<.01; * p<.05

'Contract type' also emerged as a predictor of social and domestic disruption for rotating shifts with nights (R^2 change=.017, F change=10.809, p<.001) and permanent morning shifts (R^2 change=.016, F change=7.003, p<.01). In both cases positive β-values suggested that contracted personnel suffered more disruption than those directly employed by the company. Additional predictors, not included in other categories, emerged for rotating shifts without nights where 'age' predicted a small proportion of the total variance (R^2 change =.007, F change=3.898, p<.05) with a β-weight of -.088 (p<.05) indicating that increasing age was associated with less disruption.

Additional modifier variables were also included for the permanent mornings group, with 'commuting time' emerging as the most important predictor and the 'level of responsibility' being the least important. Indeed, when taken together, the highest variance in social and domestic disruption was explained by the 5 modifier variables for this group (8.9%).

Physical Health

As can be seen in Table 7.8, for physical health, 'circadian type' and 'control over shifts' emerged as predictors in all shift types. However, in those types involving nightwork 'circadian type' was the most important predictor, whereas in those not involving nightwork 'control over shifts' emerged as the most important predictor. Negative β-weights on both variables in all cases indicated that, regardless of work pattern, a tendency toward flexibility and a higher level of perceived control were associated with fewer physical health problems.

Table 7.8. Summary statistics for stepwise regression on physical health

Shift category	Predictors	R^2 change	F change	df	β
Rotating with nights	Circadian type	.050	31.424 ***	1,596	-.212 ***
	Control over shifts	.008	5.368 *	1,595	-.093 *
	Total	***5.8%***			
Rotating without nights	Control over shifts	.032	17.390 ***	1,532	-.172 ***
	Commuting time	.015	8.280 **	1,531	.138 ***
	Circadian type	.015	8.242 **	1,530	-.121 **
	Length of A shift	.011	6.269 *	1,529	-.105 *
	Level of responsibility	.009	4.999 *	1,528	-.094 *
	Total	***8.2%***			
Permanent nights	Circadian type	.087	13.882 ***	1,146	-.273 ***
	Control over shifts	.042	6.961 **	1,145	-.206 **
	Total	***12.9%***			
Permanent mornings/days	Control over shifts	.019	7.645 **	1,404	-.129 **
	Commuting time	.015	6.314 *	1,403	.134 **
	Circadian type	.017	7.069 **	1,402	-.130 **
	Total	***5.1%***			

*** p<.001; ** p<.01; * p<.05

Whilst 'circadian type' and 'control over shifts' emerged as the only predictors of physical health in night shift categories, for those categories not involving nights, 'commuting time' was also extracted (accounting for the second largest proportion of the variance in both cases). Although the permanent nights group had the highest percentage of variance explained (12.9%), the rotating without nightwork group yielded the highest number of predictors, where the 'length of the A shift' and the 'level of responsibility' were also included.

Alertness & Safety

Tables 7.9a, 7.9b and 7.9c (overpage) show summary statistics for stepwise regression analysis on the morning, afternoon and night shifts respectively. A common feature of all models, regardless of shift type, was the inclusion of 'commuting time'. Although it only emerged as the most important predictor in one case (alertness and safety during the morning shift amongst those involved in rotating shifts with nightwork) it was nevertheless included in all models. This was perhaps not wholly unexpected, given that the factor structure for the 'alertness and safety' outcome measure included 'confidence in driving home after work'. Inspection of the β statistics revealed consistently positive values, suggesting that as commuting time increased so did concerns about safety. 'Control over shifts' was also a strong predictor, being included in all models (except that for alertness and safety during the morning shift in rotating shifts with nights). In all cases negative β-weights suggested that less control was associated with poorer alertness and perceived safety.

The importance of circadian modifiers was also underlined by the fact that all models (with the exception of permanent morning workers) included 'circadian phase'. For the rotating without nights group it emerged as the most important predictor on both the morning (R^2=.037, F=20.231, p<.001) and afternoon shifts (R^2=.079, F=45.623, p<.001), but also appeared in the equation for both groups involving nightwork (rotating with nights: R^2 change=.037, F change=23.847, p<.001; permanent nights: R^2 change=.036, F change=6.874, p<.01). Interestingly, inspection of the β-weights showed that for the morning shifts a tendency toward eveningness was associated with poorer alertness and safety whilst for the afternoon and night shifts, the trend was in the opposite direction with a tendency toward morningness being associated with greater fears for alertness and safety.

Another circadian modifier, that of 'circadian type' only appeared to be important for alertness and safety during the night shift, where it was included in models for both rotating shifts with nights, being the most important predictor overall (R^2=.053, F=33.185, p<.001), and the second most important for permanent nights (R^2 change=0.68, F change=11.650, p<.001). Here a tendency toward flexibility was associated with greater alertness and more confidence in safety.

Table 7.9a. Summary statistics for stepwise regression on alertness and safety on M shifts

Shift category	Predictors	R^2 change	F change	df	β
Rotating with nights	Commuting time	.013	7.606 **	1,596	.126 **
	Present job experience	.011	6.936 **	1,595	.103 *
	Circadian phase	.009	5.719 *	1,594	-.097 *
	Total	***3.3%***			
Rotating without nights	Circadian phase	.037	20.231 ***	1,532	-.192 ***
	Control over shifts	.033	18.715 ***	1,531	-.173 ***
	Commuting time	.024	14.285 ***	1,530	.175 ***
	Length of M shift	.021	12.620 ***	1,529	-.146 ***
	Total	***11.6%***			
Permanent mornings/days	Control over shifts	.057	24.511 ***	1,404	-.213 ***
	Commuting time	.028	12.456 ***	1,403	.162 ***
	Present shift experience	.025	11.332 ***	1,402	-.161 ***
	Total	***11.0%***			

Table 7.9b. Summary statistics for stepwise regression on alertness and safety on A shifts

Shift category	Predictors	R^2 change	F change	df	β
Rotating without nights	Circadian phase	.079	45.623 ***	1,532	.299 ***
	Control over shifts	.017	10.203 ***	1,531	-.114 **
	Commuting time	.010	5.695 *	1,530	.103 *
	Age	.007	4.200 *	1,529	-.142 **
	Present job experience	.010	6.017 *	1,528	.116 *
	Total	***12.3%***			

Table 7.9c. Summary statistics for stepwise regression on alertness and safety on N shifts

Shift category	Predictors	R^2 change	F change	df	β
Rotating with nights	Circadian type	.053	33.185 ***	1,596	-.210 ***
	Circadian phase	.037	23.847 ***	1,595	.186 ***
	Control over shifts	.026	17.242 ***	1,594	-.171 ***
	Commuting time	.014	9.607 **	1,593	.131 ***
	Age	.011	7.351 **	1,592	-.105 **
	Total	***14.1%***			
Permanent nights	Control over shifts	.089	14.212 ***	1,146	-.249 ***
	Circadian type	.068	11.650 ***	1,145	-.251 ***
	Commuting time	.061	11.179 ***	1,144	.259 ***
	Circadian phase	.036	6.874 **	1,143	.192 **
	Total	***25.4%***			

*** p<.001; ** p<.01; * p<.05

Sleep Length

Tables 7.10a to 7.10d (overpage) show summary statistics for stepwise regression analysis on the morning, afternoon and nights shifts and rest days, respectively. From Table 7.10a we can see that for sleep length during periods of morning work, the type of predictors varied according to the shift category. For example, for those working rotating shifts with nights 'commuting time' emerged as the most important predictor, with a negative β-weight indicating that longer commuting time was associated with less sleep (β=-.196, p<.001). The second predictor was 'present job experience', where, again a negative β-value indicated an association between increasing experience and less sleep (β=-.111, p<.01).

Table 7.10a. Summary statistics for stepwise regression on sleep length on M shifts

Shift category	Predictors	R^2 change	F change	df	β
Rotating with nights	Commuting time	.036	21.970 ***	1,596	-.196 ***
	Present job experience	.018	11.218 ***	1,595	-.111 **
	Circadian type	.015	9.301 **	1,594	.115 **
	Length of M shifts	.009	5.690 *	1,593	-.096 *
	Total	***7.8%***			
Rotating without nights	Control over shifts	.019	10.110 **	1,532	.125 **
	Work in UK	.009	5.153 *	1,531	.098 *
	Total	***2.8%***			
Permanent mornings/days	Control over shifts	.023	10.112 **	1,429	.152 ***
	Commuting time	.010	4.588 *	1,428	-.102 *
	Total	***3.3%***			

Table 7.10b. Summary statistics for stepwise regression on sleep length on A shifts

Shift category	Predictors	R^2 change	F change	df	β
Rotating without nights	Circadian phase	.033	18.406 ***	1,532	-.182 ***
	Level of responsibility	.015	8.622 **	1,530	.129 **
	Length of M shifts	.012	6.842 **	1,529	-.107 *
	Circadian type	.008	4.723 *	1,528	.091 *
	Total	***6.8%***			

Table 7.10c. Summary statistics for stepwise regression on sleep length on N shifts

Shift category	Predictors	R^2 change	F change	df	β
Rotating with nights	Circadian type	.076	48.749 ***	1,596	.261 ***
	Length of N shifts	.026	17.167 ***	1,595	-.246 ***
	Circadian phase	.021	14.017 ***	1,594	-.140 ***
	Age	.011	7.863 **	1,593	-.091 *
	Commuting time	.007	4.969 *	1,592	-.091 *
	Length of M shift	.006	3.937 *	1,591	.121 *
	Total	***14.7%***			
Permanent nights	Circadian phase	.037	5.555 *	1,146	-.191 *
	Total	***3.7%***			

*** p<.001; ** p<.01; * p<.05

Accounting for the least amount of variance were 'circadian type' and 'length of M shifts'. For the former, a tendency toward flexibility was associated with more sleep (β=.115, p<.01), whilst in the latter, as the length of the morning shift increased, sleep length decreased (β=-.096, p<.05). Together these 4 modifiers accounted for 7.8% of the variance.

Amongst those groups not involved in nightwork, 'control over shifts' was found to be the most important predictor, accounting for 1.9% (F=10.110, p<.01) in those working rotating shifts without nights, and 2.3% ($F=10.112$, $p<.01$) amongst those working permanent morning shifts. The direction of β-values indicated that more control was associated with more sleep. For both groups stepwise equations yielded one additional variable. For the rotating without nights group, this was whether their worked was 'within the UK' ($R^2=.009$, F change=5.153, $p<.05$). Here engineers working abroad gained more sleep between successive mornings than those based in the UK ($\beta=.098$, $p<.05$). For those working permanent mornings 'commuting time' ($R^2=.010$, F change=4.588, $p<.05$) was extracted, where $\beta=-.102$ ($p<.05$) indicated that, as expected, a shorter commuting time was associated with more sleep.

Predictors of afternoon and night shift sleep length were similar, with both circadian variables and the length of shifts extracted. However, although both 'circadian type' and 'circadian phase' entered the equation for the length of sleep between successive afternoon shifts (rotating without nights) and successive night shifts (rotating with nights), their relative importance was divergent. 'Circadian phase' accounted for the highest proportion of variance for sleep length between afternoon shifts ($R^2=.033$, $F=18.406$, $p<.001$), whilst 'circadian type' dominated the prediction of sleep length between night shifts ($R^2=.076$, $F=48.479$, $p<.001$). Regardless of their position in the equation, a tendency toward morningness was associated with less sleep, whilst a tendency toward flexibility was associated with more sleep.

In terms of shift length, the number of hours worked during morning shifts entered the equation for both sleep length during periods of afternoon shifts (rotating without nights: $R^2=.012$, F change=6.842, $p<.01$) and night shifts (rotating with nights: $R^2=.006$, F change=3.937, $p<.05$), although for the latter the number of hours worked during night shifts was more important ($R^2=.026$, F change=17.167, $p<.001$). Interestingly, inspection of the β statistics showed that, whilst longer morning shifts were associated with less sleep between successive afternoon shifts (rotating without nights: $\beta=-.107$, $p<.05$), between successive night shifts, longer morning shifts were associated with more sleep (rotating with nights: $\beta=.121$, $p<.05$). For this latter group, longer night shifts were associated with less sleep between successive shifts ($\beta=-.246$, $p<.001$).

Additional modifier variables were also included in the models for rotating groups. Amongst those not involved in nightwork, less work responsibility was associated with more sleep between successive afternoon shifts ($\beta=.129$, $p<.01$), whilst for rotating shifts involving nightwork, being younger ($\beta=-.091$, $p<.05$) and having a shorter commuting time (β-.091, $p<.05$) were associated with more sleep between successive night shifts.

As can be seen from Table 7.10c, only 'circadian phase' emerged as a predictor of the length of sleep between successive night shifts amongst those working permanent nights (R^2=.037, F=5.555, p<.05). In line with the findings above, M-types gained less sleep than E-types (β=-.191, p<.05).

Table 7.10d. Summary statistics for stepwise regression on sleep length on rest days

Shift category	Predictors	R^2 change	F change	df	β
Rotating with nights	Present shift experience	.033	20.417 ***	1,590	-.129 **
	Age	.011	7.029 **	1,589	-.120 **
	Total	***4.4%***			
Rotating without nights	Age	.013	6.787 **	1,504	-.115 **
	Total	***1.3%***			
Permanent nights	No predictors	-	-	-	-
Permanent mornings/days	Age	.038	13.303 ***	1,338	-.186 ***
	Contract type	.016	5.735 *	1,337	-.127 *
	Total	***5.4%***			

*** p<.001; ** p<.01; * p<.05

Few predictors emerged for sleep length during rest days (see Table 7.10d). In the case of permanent nightworkers no variables were extracted. However, in the remaining shift groups a common modifier was that of 'age', where a negative β-weight in all cases suggested that older workers obtained less sleep than younger workers. Whilst age was the only variable to predict sleep length for those working rotating shifts with nights, two of the remaining shift groups had unique predictors. The most important variable for those working rotating shifts with nights was 'present shift experience' (R^2=.033, F=20.417, p<.001; β=-.129, p<.01) where increasing experience was associated with shorter sleep, whilst for those working permanent mornings, 'contract type' accounted for a further 1.6% (F change=5.735, p<.05; β=-.127, p<.05). Here contracted personnel gained less sleep than those employed directly by the company.

Hierarchical Regression Analysis

Categories Entered as Individual Blocks

Summary statistics for hierarchical regression analysis where modifiers were entered individually in separate models are shown in Table 7.11 (overpage). In terms of attitudes towards shiftwork, demographic variables accounted for the highest proportion of variance for those working rotating shifts without nights and permanent nightworkers (12.7%, F=7.615, p<001, and 8.5%, F=1.615, p>.05, respectively), although the latter failed to reach significance. For those working rotating shifts with nights, circadian variables accounted for the highest proportion of variance (7.8%, $F=28.295$, $p<.001$), whilst for those working permanent mornings, work related variables (5.3%, $F=30.199$, $p<.001$) yielded the most predictive power.

Demographic variables predicted the most variance in alertness and safety on the morning shift in all shift categories, although this ranged from 3.4% (rotating with nights) to 8.8% (rotating without nights). For alertness and safety during the afternoon and night shifts, circadian modifiers consistently accounted for the highest proportion of variance, with values across shift types being relatively high (ranging from 8.0% amongst those working rotating shifts without nights through to 12.6% amongst permanent nightworkers).

In terms of physical health, circadian modifiers emerged as the strongest category for those shift types involving nightwork, whereas when nightwork was not involved, demographic variables were the stronger set of predictor variables. For social and domestic interference, demographic modifiers predicted the largest proportion of variance in all 4 groups, although again, the percentages varied from just 3% (rotating shifts with nights) to 9.4% (permanent mornings). Only the equations for rotating shifts without nights and permanent mornings reached significance.

When taken together, demographic variables emerged as the strongest set of predictors for sleep length between successive shifts in most (but not all) instances. Between successive afternoon shifts (rotating without nights) and rest days (all 4 shift groups) demographic variables consistently accounted for the highest proportion of variance overall. Between successive morning shifts, demographic variables were strongest in both rotating groups. For those working permanent mornings work related variables were the most important, being the only category of predictors to yield a significant model. Between successive night shifts, sleep length was best predicted by circadian variables, where they accounted for the highest proportion of variance in those working rotating shifts with nights ($R^2=.096$, $F=34.324$, $p<.001$). Although demographic variables explained the most variance amongst those working permanent nights ($R^2=.068$, $F=1.273$, $p>.05$), this failed to reach significance. Indeed in this instance, circadian variables were the only category to reach significance when entered as a block on their own ($R^2=.043$, $F=3.777$, $p<.05$).

In all equations summarised in Table 7.11, inspection of the β values supported the stepwise regression analysis, where the only variables found to significantly add to the equations were those that had emerged in the stepwise models for each outcome variable.

Table 7.11. Summary statistics for hierarchical regression (individual blocks) amongst maintenance engineers

	Demographic		Circadian		Work related	
	R^2	F	R^2	F	R^2	F
Attitudes toward Shiftwork:						
Rotating with nights	.028	1.685	**.078**	**28.295*** **	.026	17.667***
Rotating without nights	**.127**	**7.615*** **	.013	4.161*	.038	24.492***
Permanent nights	**.085**	**1.615**	.045	4.363*	.043	8.380**
Permanent mornings	.038	1.734	.006	1.540	**.053**	**30.199*** **
Social & Domestic Disruption:						
Rotating with nights	**.030**	**1.826**	.026	8.982***	.005	3.694
Rotating without nights	**.060**	**3.312*** **	.006	1.844	.021	13.239***
Permanent nights	**.043**	**0.773**	.036	3.422*	.021	4.018*
Permanent mornings	**.094**	**4.550*** **	.000	0.095	.015	8.244**
Physical Health:						
Rotating with nights	.031	1.857*	**.056**	**19.826*** **	.014	9.803**
Rotating without nights	**.046**	**2.514** **	.019	6.181**	.032	20.560***
Permanent nights	.079	1.500	**.089**	**9.061*** **	.055	10.931***
Permanent mornings	**.043**	**1.986* **	.021	5.772**	.019	10.351***
Alertness & Safety – M shift:						
Rotating with nights	**.034**	**2.095* **	.012	3.936*	.006	3.893*
Rotating without nights	**.088**	**5.043*** **	.037	12.061***	.031	19.962***
Permanent mornings	**.079**	**3.787*** **	.001	0.277	.057	32.155***
Alertness & Safety – A shift:						
Rotating without nights	.033	1.770	**.080**	**25.564*** **	.019	11.767***
Alertness & Safety – N shift:						
Rotating with nights	.032	1.946*	**.089**	**32.190*** **	.037	25.401***
Permanent nights	.084	1.590	**.126**	**12.220*** **	.089	16.938***
Sleep Length – M shift:						
Rotating with nights	**.072**	**4.563*** **	.016	5.255**	.001	0.881
Rotating without nights	**.047**	**2.584** **	.000	0.132	.019	11.573***
Permanent mornings	.021	1.159	.005	1.130	**.023**	**11.314*** **
Sleep Length – A shift:						
Rotating without nights	**.045**	**2.479** **	.042	12.469***	.003	1.532
Sleep Length – N shift						
Rotating with nights	.064	4.046***	**.096**	**34.324*** **	.013	8.822**
Permanent nights	**.068**	**1.273**	.043	3.777*	.013	2.186
Sleep Length – Rest days						
Rotating with nights	**.064**	**3.995*** **	.004	1.296	.000	0.009
Rotating without nights	**.033**	**1.679**	.003	0.861	.002	0.095
Permanent nights	**.037**	**0.675**	.009	0.746	.000	0.082
Permanent mornings	**.058**	**2.556** **	.011	2.042	.002	0.917

*** p<.001; ** p<.01; * p<.01

Categories Entered Sequentially

To determine whether each of the categories of modifiers predicted a unique proportion of the variance once the effects of covariates had been eliminated, further hierarchical analysis was performed, where the groups of variables were entered sequentially in the order: demographic, circadian, work related.

As can be seen in Table 7.12 (overpage), hierarchical multiple regression found that, after the entry of demographic variables in step 1, circadian variables in step 2 significantly improved the prediction of attitudes towards shiftwork in all groups except permanent mornings. For example, for rotating shifts with nights, circadian variables explained a further 7.6% of the variance (F change=24.683, $p<.001$), a further 4.8% in permanent nightworkers (F change=3.817, $p<.05$) and just 1.4% for those working rotating shifts without nights (F change=4.254, $p<.05$). Inspection of the β statistics in all cases supported the earlier stepwise models where the ability to sleep at unusual times and in unusual places was the strongest predictor for the two nightworking groups (rotating: $\beta=.249$, $p<.001$; permanent: $\beta=.206$, $p<.05$) and the third strongest for those working rotating shifts without nights ($\beta=.113$, $p<.01$). Work related variables added in step 3 resulted in a significant increase in the predictive power of models for all 4 groups, although was strongest for those not involving nightwork. As suggested by the stepwise analysis, where 'control over shifts' was the most important predictor, for permanent mornings, only work related variables resulted in a significant increase in the predictive power of the model once the effects of demographic and circadian variables had been held constant (R^2 change=.048, F change=20.827, $p<.001$).

In terms of alertness and safety, the entry of circadian variables in step 2 significantly increased the predictive power of the model in all cases, (except that during morning shifts amongst the permanent mornings group), thus suggesting that demographic modifiers had little mediating impact on circadian modifiers for this outcome. The biggest increases were found for alertness and safety during the night shift. Permanent nights saw an increase of 14.5% in explained variance (F change=12.886, $p<.001$), whilst the model derived for rotating shifts with nights saw an increase of 9.2% (F change=30.612, $p<.001$). The addition of circadian variables had the least effect overall on alertness and safety during the morning shifts where it's unique contribution was 2.9% (F change=8.618, $p<.001$) in the rotating without nights group and 1.1% (F change=3.469, $p<.05$) in the rotating with nights group.

The entry of work related variables in step 3 also significantly improved the predictive power of the model in all cases (except that during morning shifts amongst those working rotating shifts with nights), thus suggesting that, when taken together, demographic and circadian modifiers had little mediating effect on the predictive power of work related variables in terms of alertness and safety, not supporting the hypothesised direction of effects.

Table 7.12. Summary statistics for hierarchical regression (entered sequentially) amongst maintenance engineers

	Demographic		Circadian		Work related	
	R^2	F	R^2 change	F change	R^2 change	F change
Attitudes toward Shiftwork:						
Rotating with nights	.028	1.685	.076	24.683***	.017	11.122***
Rotating without nights	.127	7.615***	.014	4.254*	.038	23.832***
Permanent nights	.085	1.615	.048	3.817*	.035	5.739*
Permanent mornings	.038	1.734	.005	1.011	.048	20.827***
Social & Domestic Disruption:						
Rotating with nights	.030	1.826	.032	9.992***	.008	4.966*
Rotating without nights	.060	3.312***	.006	1.546	.020	11.347***
Permanent nights	.043	0.773	.043	3.210*	.026	3.394
Permanent mornings	.094	4.550***	.000	0.038	.008	3.475
Physical Health:						
Rotating with nights	.031	1.857*	.050	15.975***	.008	4.948*
Rotating without nights	.046	2.514**	.019	5.297*	.025	14.226***
Permanent nights	.079	1.500	.096	7.988***	.025	4.266*
Permanent mornings	.043	1.986*	.019	4.091*	.011	4.521*
Alertness & Safety – M shift:						
Rotating with nights	.034	2.095*	.011	3.469*	.005	3.344
Rotating without nights	.088	5.043***	.029	8.618***	.024	14.493***
Permanent mornings	.079	3.787***	.001	0.128	.038	16.782***
Alertness & Safety – A shift:						
Rotating without nights	.033	1.770	.087	25.886***	.011	6.782**
Alertness & Safety – N shift:						
Rotating with nights	.032	1.946*	.092	30.612***	.025	16.910***
Permanent nights	.084	1.590	.145	12.886***	.048	9.108**
Sleep Length – M shift:						
Rotating with nights	.072	4.563***	.013	4.260*	.000	0.017
Rotating without nights	.169	0.997	.091	2.591	.221	17.428***
Permanent mornings	.025	1.150	.007	1.326	.020	8.130**
Sleep Length – A shift:						
Rotating without nights	.195	0.942	.142	3.530*	.094	5.279*
Sleep Length – N shift						
Rotating with nights	.064	4.046***	.088	30.355***	.002	1.289
Permanent nights	.219	0.374	0.75	0.531	.026	0.340
Sleep Length – Rest days						
Rotating with nights	.064	3.995***	.002	0.652	.001	0.522
Rotating without nights	.042	0.213	.012	0.258	.023	1.005
Permanent nights	.037	0.052	.027	0.146	.001	0.001
Permanent mornings	.058	2.170*	.013	2.239	.000	0.051

*** p<.001; ** p<.01; * p<.01

A consistent picture emerged in the prediction of physical health with the entry of circadian variables in step 2 and work related variables in step 3 increasing the predictive power of the equation in all 4 groups. Such a trend suggested that circadian variables had an impact on the prediction of physical health since it showed an improvement even when the mediating effects of demographic variables had been partialled out. The same was also true of work related variables, which continued to contribute to the prediction of physical health once any covariation with demographic or circadian variables had been eliminated. In support of the stepwise analysis, the introduction of circadian variables had the biggest impact amongst those groups who worked nights as part of their shift system. For example, permanent nights showed an increase of 9.6% (F change=7.988, $p<.001$) in predictive power with the entry of circadian variables, whilst those working rotating shifts with nights showed a 5% rise (F change=15.975, $p<.001$). Stepwise analysis found circadian type to be the strongest individual predictors in both cases (see Table 7.7). Furthermore, the introduction of work related variables in step 3 had the biggest impact on those working rotating shifts without nights (R^2 change=.025, F change=14.226, $p<.001$) and permanent nights (R^2 change=.025, F change=4.266, $p<.05$), both of which featured 'control over shifts' as a prominent predictor in stepwise analysis.

For social and domestic disruption a clear split in the findings appeared, where the entry of circadian variables in step 2 significantly improved the prediction of disruption for shift systems involving nightwork. Furthermore, when work related variables were added in step 3 only the rotating groups showed an improvement in the predictive power of the model. Such findings suggest that, for shift systems involving nightwork, circadian modifiers such as 'phase' and 'type' still predict social and domestic disruption when the mediating effects of demographic variables have been partialled out. This was supported by the findings from stepwise analysis. For rotating shift systems, however, work related variables were stronger, showing little mediating influence of demographic or circadian modifiers.

Finally, in terms of sleep length, between successive morning shifts the entry of circadian variables significantly increased the predictive power of the model in only those working rotating shifts with nights (R^2 change=.013, F change=4.260, $p<.05$), whilst for the remaining groups, only work related variables added in step 3 resulted in such an increase (rotating without nights: R^2 change=.221, F change=17.428, $p<.001$; permanent mornings: R^2 change=.020, F change=8.130, $p<.01$). Circadian variables also had the same effect for sleep length between successive afternoon shifts (rotating without nights: R^2 change=.142, F change=3.530, $P<.05$) and for night shifts, although this was only true for those working rotating shifts with nights (R^2 change=.088, F change=30.355, $p<.001$). Further, whereas the introduction of work related variables in step 3 further increased the predictive power of the model for afternoon shift sleep length, it failed to do so in either of the shift groups involving nightwork. Sleep length during rest days showed a contrasting picture, where neither the entry of circadian variables in step 2 nor work related variables in step 3 increased the strength of equations in any group.

7.4. Discussion

In general the findings supported those from previous chapters. Exploratory factor analysis of the outcome variables revealed similar trends to Chapter 6, where, despite smaller numbers of outcome variables being employed, they nevertheless could be reduced into functional domains that were reliable and had an interpretable factor structure. Although attempts were made to support the factor structures previously found, this was not always possible given the abridged nature of the questionnaire used. As with the previous chapter, the 4 physical health items loaded highly and were subsumed into a single factor. Furthermore, social and domestic disruption and the perceived advantages of shiftwork also loaded highly on single factors. However, the omission of measures of psychological health and sleep quality meant that the "Psychological Health and Sleep" factor derived in the previous chapter could not be validated in this instance. In the absence of such measures, alertness, that had loaded highly along with measures such as cognitive and somatic anxiety, fatigue, sleep quality and neuroticism in Chapter 6 was, in this case, found to be strongly associated with the two items relating to risk and perceived safety. Interestingly, when comparing such a finding with the models of shiftwork tolerance, this type of association is not mentioned. Almost all models are based around the premise that shiftwork leads to illness and disease, rather than accidents and risks to safety (with the exception of Folkard, 1993). Where 'risk' is mentioned it relates only to smoking or dietary habits. Whilst such a finding questions the depth and generalisation of models of shiftwork tolerance, it is interesting to note that this relationship was identified in the interviews chapter where the interaction of variables on the early shift (Figure 5.1a) highlighted a link between alertness and concerns about road safety.

Correlations between outcome measures revealed positive relationships between 'alertness and safety' and 'physical health'. In all cases more concern over alertness and safety was associated with more physical health problems. Although this was true for all groups, the strongest correlation was seen for the night shift amongst the appropriate groups. 'Social and domestic interference' and 'perceived advantages of shiftwork' were also highly correlated, where greater impairment to social and domestic life was associated with a less positive attitude towards shiftwork. This is not surprising given that, as with Chapter 6, the two measures loaded highly on a single factor. In the previous chapter, it was suggested that the interaction could be due to the fact that the 17-item Advantages of Shiftwork scale (Taylor *et al.*, 1997) contained a number of items relating directly to social and domestic events similar to those used in the Social and Domestic Survey (Barton *et al.*, 1995). In contrast, only single item measures were used here that did not specify the type of advantages/events. Thus, such a finding suggests that the two may be inherently linked, irrespective of specific types of advantages or social/domestic occasions and, therefore, implies that the two dimensions are more strongly associated than previously assumed.

A number of correlations emerged between sleep lengths and alertness and safety according to different shift types. Such a pattern of findings was not wholly unexpected especially in those involved in rotating shifts. In support of both the interviews chapter and the large body of literature, rotating schedules are characterised by carry-over effects, where other shift types included in the system can influence tolerance. So for example, the interview summaries highlighted how those working rotating shifts without nights tended to wake at a similar time when working both early's and late's, finding it particularly difficult to go back to sleep during periods of late shifts (Åkerstedt and Gillberg, 1981; Åkerstedt *et al.*, 1991), encountering insufficient rest, leading to tiredness. Although sleep length was not found to correlate with any other outcome measure when analysed for the whole sample, when analysed by shift group all showed negative relationships with alertness and safety. For example, for permanent mornings, sleep length on the morning shift negatively correlated with alertness and safety during the morning shift. Although these values were not high (ranging from -.135 to -.449) in all cases a decrease in sleep length was associated with an increase in perceived risk. This not only further validates the link purported during the interviews (Figure 5.1a) but also allows the generalisation of the trend to a different industry and to an array of shift types, furthering the knowledge gained from previous chapters.

In terms of the extent of problems, those working rotating shifts without nightwork appeared to show the lowest tolerance overall, having the most impairments to physical health, social and domestic life, and alertness and safety (morning shift only), the least sleep (morning shift only) and the least favourable attitude towards shiftwork. In contrast those working rotating shifts with nightwork (generally advocated to be worse than rotating without nights in the literature) showed fewest impairments of all 4 groups on social and domestic life and attitudes towards shiftwork, and was surpassed by only the permanent mornings group on physical health. Although this group showed the least impairment to alertness and safety for morning shifts, and indeed, even less than those working permanent mornings, they showed a high level of impairment in relation to the night shift. Nonetheless, in support of the literature certain outcomes, namely sleep and alertness and safety, showed less impairment in those working permanent shifts (e.g. Chan *et al.*, 1989; Wilkinson *et al.*, 1989; Folkard 1997; Pilcher *et al.*, 2000). Thus, overall the extent of the problems suffered was dependent upon the shift worked, with the pattern of results questioning the traditional umbrella terms of 'rotating' and 'permanent'. In the present study the two types of rotating shift systems showed a contrasting pattern of impairment in terms of the magnitude of specific outcomes. This was also true, to a lesser extent, for those working permanent shifts. As discussed below, shift characteristics, such as the presence of nightwork, appeared to be the common link in determining the relationships between outcomes and modifiers. However the speed of rotation may also have played a role here since the predominant system worked amongst the nightworking group was a rapidly rotating 2D2N4R, whereas the majority of the no nights group worked a much slower rotation, comprising more shift types (7M4R7A3R or 3M4A3R4M3A3R). Furthermore, whilst the majority of the former worked 12h shifts, the latter worked 8h.

Whilst it may be argued that the high percentage of specific shift systems within each of these categories may be responsible for the trends seen, such a pattern of findings may also be attributable to the differences in the biographical characteristics of the groups. For example, earlier analysis on demographic information showed the rotating with nights group to be significantly younger than those working rotating shifts without nightwork and permanent mornings. Furthermore, the rotating without nights group also showed the longest experience of the current shift and shiftwork in general. Significant differences between groups were also found on all modifiers except gender and whether the work was UK based. Consequently, the underlying nature of the groups may be responsible for the disparate findings.

Due to the emphasis on shift system characteristics within the questionnaire, rather than the impact of such characteristics on the health and well-being of workers, few modifiers were used in the analysis. Of those that did appear, emphasis was on demographic variables. However, whereas the total variance explained was reasonably high in the previous chapter (being greater than 30% in some cases), in this chapter they were comparatively weaker. It is difficult to conclude whether this was due to the larger sample employed here, since it is known that as the number of participants per dependent variable increases the R^2 value decreases, or whether the difference in the numbers and formatting of the outcome variables used were responsible. In order to answer such questions further research, testing each possibility, is needed.

The shift dependent trends noted earlier were also seen in the regression analysis. As with the previous chapter, the number and predictive validity of modifiers varied according to the outcome under investigation. However, here the pattern of findings also varied across shift characteristics. Despite this, there were a number of core modifiers that emerged for most, if not all, equations (e.g. 'circadian type', 'commuting time' and 'control over shifts').

In terms of attitudes towards shiftwork a distinction between permanent and rotating groups was evident, with 'commuting time' and 'control over shifts' emerging as important predictors in the former, and 'present shift experience' and 'circadian type' for the latter (although circadian type was also extracted for permanent nights). The extraction of the work related variable 'control over shifts' supported the findings from Chapter 6 where a related variable, that of 'general job satisfaction', was found to be the most important modifier for this outcome. Similarly, whilst 'commuting time' was important for permanent workers in the present study, in Chapter 6, 'living near to the site' was extracted.

On the physical health factor, equations for all groups yielded 'circadian type' and 'control over shifts', with the solutions for the rotating with nights and permanent nights groups containing only these variables in the same order of magnitude. The fact that the same variables emerged regardless of shift type underlines their importance in the prediction of physical health. Interestingly this also supports the findings from the previous chapter where languidity and the work related variable of 'job demand' were extracted for the whole sample. However, whilst circadian type was more important than control over shifts for groups working nights, the opposite was true for those working rotating shifts without nights and permanent mornings, again highlighting a shift dependent effect.

In terms of social and domestic disruption, 'circadian type' was the most significant predictor amongst nightworking groups, whereas 'present shift experience' and 'control over shifts' were common predictors for those groups not involved in nightwork. This did not translate well onto previous results. Similarly, for sleep length between successive shifts, the results obtained here offered little support to those found in the previous chapter, where few modifiers were extracted. In contrast, sleep length was predicted by the highest number of modifiers overall, although again shift dependent effects were noted. For example, in Chapter 6 no predictors emerged for sleep length between successive morning shifts, whilst in this instance control over shifts was important for those working rotating shifts without nights and permanent morning workers. Furthermore, for those working rotating shifts with nights, commuting time was more important. In Chapter 6, shiftwork experience and age emerged as predictors of sleep length on the late shift, whilst neither modifier emerged here. Instead a strong circadian theme was derived with both circadian phase and circadian type entering the equation. The predominance of circadian characteristics was mirrored in the prediction of sleep length between successive night shifts where both circadian type and phase were included in the equation for the rotating with nights group, with circadian phase being the only modifier extracted for those working permanent nights. For sleep length between rest days some consistency between the two studies was found. Chapter 6 found age to be the most important predictor overall, whilst in the present study age was found to be the most important predictor for all groups except those working permanent nights.

In contrast, in the next stage of analysis, where modifiers were entered in individual blocks, no support for the previous chapter was found, although again, shift dependent effects were evident. For example, from Table 7.13 we see that, in terms of social and domestic interference, although demographic variables were the most important category of modifiers across all four shift groups, for nightworking groups, circadian characteristics were more important than those relating to work. In contrast for those groups not involving nights, work characteristics were more important. Similarly, whilst circadian variables accounted for the highest proportion of variance in physical health for the nightworking groups, demographic variables were more important amongst dayworking groups only.

Table 7.13. Summary of trends in hierarchical regression (individual blocks)†‡amongst maintenance engineers

	Attitudes	Physical Health	Social & Domestic Interference	Alertness & Safety		
				Morning	Afternoon	Night
Rotating with nights	C – D – W	C – D – W	D – C – W	D – C – W	-	C – W – D
Rotating without nights	D – C – W	D – W – C	D – W – C	D – C – W	C – D – W	-
Permanent nights	D – C – W	C – D – W	D – C – W	-	-	C – W – D
Permanent mornings	W – D – C	D – C – W	D – W – C	D – W – C	-	-

D=Demographic; C=Circadian; W=Work
† predictors presented in order of importance in all cases
‡ reflects higher impairments in all outcome measures

Further hierarchical analysis where the categories of modifiers were entered sequentially, in most cases, contradicted the hypothesised direction of effects (i.e. that demographic variables would mediate the impact of circadian variables and that the two in combination would mediate the impact of work related modifiers). In terms of physical health the addition of circadian modifiers in step 2 and work related modifiers in step 3 both increased the predictive power of the equation – an effect that held true across groups. This finding also failed to support the previous chapter where only the addition of circadian variables resulted in a more powerful equation.

In terms of attitudes towards shiftwork a similar pattern emerged for all groups except those working permanent mornings. Here the predictive power of the equation was only heightened with the addition of work related variables in the final step. With the exception of the aforementioned group, this trend fully supported the analysis in Chapter 6. In a similar vein to the previous chapter, few positive results were found for the length of sleep gained between successive shifts. Between morning shifts, circadian variables increased the predictive power of the equation in those working rotating shifts with nights, whilst for groups not involved in nightwork only the entry of work related variables in the final step resulted in a significance increase. In contrast, a more consistent picture arose in the prediction of sleep between rest days where the addition of neither circadian modifiers in step 2, nor work related modifiers in step 3, increased the significance of the equation amongst any of the four groups included. This supported the findings from Chapter 6.

In summary, the findings derived here showed some support for those from previous chapters. However, in the analysis of shiftwork tolerance across shift patterns it was evident that the relative predictive strength of modifiers was dependent on both the outcome measure under investigation and shift characteristics. Rather than seeing a split between rotating and permanent shifts, a more reliable pattern of results emerged between those involved in nightwork (rotating with nights and permanent nights) and those not (rotating without nights and permanent mornings). This challenged the traditional approach of a rotating/permanent divide. In stepwise analysis there was a strong circadian element to the prediction of outcome variables for those working nights only, with circadian type being the most important predictor for attitudes towards shiftwork, physical health, and social and domestic interference. Both circadian type and phase were extracted as important predictors of alertness and safety during the night shift, whereas for sleep length between successive nights both modifiers emerged for rotating shiftworkers. For the permanent nights group only circadian type was extracted. Given that nightwork poses the most upheaval to man's natural diurnal rhythms this is perhaps to be expected. Interestingly when categories of modifiers were entered in individual blocks, this relationship only held for physical health, and alertness and safety. This trend is pursued further in the remaining chapters.

In conclusion, although there was limited support for the results of the previous two chapters, a number of methodological weaknesses should be taken into account when assessing the findings upon which these conclusions are based. Given the abridged nature and depth of the survey used in this instance, the two studies are not directly comparable. The 4 page questionnaire used here had a different structure than the 20+ pages that constituted the SSI, SOS or the survey used previously, with a greater emphasis on shift system features rather than measures relating to outcomes of shiftwork or possible modifying variables. Furthermore, the shortened versions of the questions, such as those relating to attitudes towards shiftwork and social and domestic interference, gave fewer cues to respondents, whereas in the previous survey respondents were asked to rate specific items within each of these scales. On some measures rating scales ranged from 1-9 rather than 1-5 as used in Chapter 6. Such differences may have affected the way in which respondents approached certain questions.

Whilst the results obtained allow us to gain a better understanding of the relationships between outcomes and modifiers of shiftwork tolerance, which in turn help to validate and further develop the models of shiftwork tolerance, the present study represented only a cross sectional approach, and therefore conclusions as to cause and effect could not be addressed. Chapters 8 and 9 explore the research questions from a longitudinal perspective.

8

THE EFFECT OF SHORT-TERM EXPOSURE ON SHIFTWORK TOLERANCE

8.1. Introduction

This is first of two studies exploring whether the relationships uncovered in previous chapters exist in a longitudinal design. In this chapter the effect of a short-term shift system on the relationships between outcomes and modifiers of shiftwork tolerance are assessed, and stems from evidence suggesting that exposure to a shift is a better predictor of symptoms than the length of shiftwork experience (Tasto *et al.*, 1978). Evidence from the literature on this area is sparse with few longitudinal studies reported (e.g. Meers *et al.*, 1978). To the author's knowledge very little research has been conducted on a wide range of outcome and modifier variables in this type of longitudinal short-term approach, although those that do exist have found deterioration in subjective health (Meers *et al.*, 1978) mood (Bohle *et al.*, 1993), gastrointestinal symptoms and sleep disorders (Kundi, 1986, Wynne *et al.*, 1986). However, more recent evidence suggests that it is not merely the frequency of complaints that change over time, but also the internal relationships between problem domains. Thus, according to Nachreiner *et al*, (1995), with increasing shiftwork experience disorders that share a common feature, most notably the disruption of circadian synchronisation, form a dominant dimension of impairment. Bohle *et al.* (1989) have also suggested that the relative efficacy of specific modifier variables varies with experience of shiftwork.

In Chapter 4 we introduced models of shiftwork tolerance posited to date. Whilst the discussion aimed to highlight the major differences between them, one element they all have in common is that they fail to incorporate tolerance of shifts over time. Haider *et al.* (1988) were the only authors to mention a distinction between inexperienced and experienced shiftworkers, although this element was not explicitly incorporated in the diagrammatic version of the model they proposed. Furthermore, whilst the later models of Smith *et al.* (1999) introduce the importance of exploring how relationships may be affected by the type of industry, in terms of the strength and direction of relationships between outcomes and modifiers, other important questions such as how these relationships may be affected by time on shift, have received little attention. Exploring such a question has major implications in understanding the evolution of shiftwork problems.

In this instance shiftworkers were tested on a range of measures during their first and final week of a 5 week cycle. Such a design is particularly useful in that, by conducting the study over a short period, few shiftworkers were expected to be lost through attrition associated with the healthy shiftworker effect, as is the risk with longer-term studies of this type. However the question here was whether 5 weeks would be long enough for changes to manifest themselves and therefore be detectable in the variables employed.

8.2. Method

8.2.1. Background Information

The research was requested by the Occupational Health Department of a large UK oil refinery who wanted to assess the impact of the plant-wide, short-term 'Turnaround Shifts', which took place for 5-10 weeks every 4 years. During this turnaround phase, the plant halted all normal functioning whilst the machinery was fully serviced. At this time the workforce at the site doubled to over 2000 personnel, with 500 directly employed by the company and 1500 or more contracted from outside. During normal operations, the majority of employed personnel worked permanent day shifts or a 5-team, continuous 12h rotating system (day: 06:00-18:00; night 18:00-06:00) over an 18-week cycle, as shown in Table 8.1. Those contracted in from outside the plant came from a variety of shiftworking backgrounds, although all continually travelled from plant to plant performing 'shutdown' work.

Table 8.1. 2-2-3 system normally worked at the oil refinery

	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
Week 1	D	D			N	N	N
Week 2			D	D			
Week 3	N	N			D	D	D
Week 4			N	N			
Week 5	D	D			N	N	N
Week 6			D	D			
Week 7							
Week 8							
Week 9			D	D			
Week 10	N	N			D	D	D
Week 11			N	N			
Week 12	D	D			N	N	N
Week 13			D	D			
Week 14	N	N			D	D	D
Week 15			N	N			
Week 16	D	D			N	N	N
Week 17							
Week 18							

N = Nights; D = Days; shading = Rest Day

Taking place during March and April of 2001, the shift schedule in operation at the plant was a 35 day cycle of either 10h days (07:30-17:30, Monday through Thursday, Saturday and Sunday, and 08:00-18:00 on Friday) or 10h nights (20:00-06:00). According to Article 5 of the Working Time Directive (1998), "per each seven-day period, every worker is entitled to a minimum uninterrupted rest period of 24 hours". Thus, workers were required to take one day off a week or two days off a fortnight. However, it was estimated by the shift manager that only approximately 800 personnel would do so, and it was hoped that comparisons could be made between those who had taken days off and those who had not in order to investigate whether rest days had any beneficial impact.

8.2.2. *Questionnaire Administration*

The study aimed to survey workers during the first and final weeks of the cycle to assess how they had adapted over the turnaround period. All workers at the plant were invited to participate through both a company-wide e-mail and directly by their line supervisors. Questionnaires were administered via 3 methods: (1) Electronically: Recent research has shown the effectiveness of the web in encouraging people to respond to surveys (Cook, Heath and Thompson, 2000), thus in an attempt to increase the overall response rate, an electronic version of the survey was designed and both sent and returned via e-mail to those who requested it; (2) Issued by supervisors and managers for personnel to complete during their breaks; (3) Administered during arranged sessions during company time. Although no time restrictions were enforced, most surveys were completed within approximately 20 minutes. All of those who completed both baseline and follow-up were given two National Lottery Scratchcards® in thanks for their participation.

8.2.3. *Participants*

At Time 1 (T1) completed questionnaires were returned from 98 workers of the initial 153 who received a survey, giving a response rate of 64.05% overall. All workers were tested within the first 10 days of beginning the shift system. At Time 2 (T2) the response rate was considerably poorer with only 39 (39.39%) of the original cohort completing a questionnaire. At T1, 94.9% (n=93) worked the day shift, with the remaining 5.1% (n=5) working the night shift. At T2, 89.74% (n=35) worked the day shift, whilst 10.26% (n=4) worked the night shift. Due to the small numbers of nightworkers involved at both time points these were excluded from further analysis.

In terms of the administration methods used, at T1 the traditional paper-based versions completed during arranged testing sessions proved to be the most fruitful, with 60 returned (61.22%). In comparison, of those issued via e-mail, 25 (25.51%) were returned, whereas, of those issued by supervisors, only 13 (13.27%) were collected. At T2, e-mail administration proved to be most successful with 19 (48.72%) questionnaires returned, and a further 10 (25.64%) from each of the other two methods used.

8.2.3.1. Permanent Days

Demographical details are shown in Table 8.2a and 8.2b. Within the 90 males and 3 females working the day shift, mean age was 43.17 (SD 10.21; range 18-65 years). As expected, this was reflected in the large variation in work, and shiftwork experience. Work experience ranged from as little as 1 month to 46 years ($\bar{x}$ 24.83 yrs; SD 11.65 yrs). Similarly, shiftwork experience ranged from 1 month to 43 years ($\bar{x}$ 9.16 yrs; SD 11.41 yrs). 21.5% (n=20) of those working the dayshift had no experience of shiftwork prior to their present position, whilst 22.6% (n=21) had no experience of working turnaround shifts at this plant before.

Table 8.2a. Demographical details (mean, SD) of the sample

	Permanent days	
	$\bar{x}$ (SD)	Range
Age (yrs)	43.17 (10.21)	18-65
Work experience (yrs)	24.83 (11.65)	1-46
Shiftwork experience (yrs)	9.16 (11.41)	1-43
Contracted hours/week	52.39 (15.19)	37-88
Actual hours/week	63.33 (10.86)	37.5-90
Locality (miles)	18.59 (12.53)	1-70
Commuting time (mins)	41.45 (22.16)	10-100
Number of children	1.52 (1.27)	0-6
Restfulness of day off	4.80 (2.52)	1-9

Whilst the number of hours personnel were contracted to work each week was 52.39 (SD 15.91, range 37-88), the mean number of hours actually worked per week was considerably higher at 63.33 (SD 10.86, range 37.5-90.0). Of those sampled, 73.1% (n=68) were contractors who had been drafted in from outside the plant, with 26.9% (n=25) directly employed by the company. All contractors were living away from home in temporary accommodation throughout the duration of the turnaround period. In terms of locality only 31.3% were based locally (that is to say within 10 miles of the site), with a variation of 1 to 70 miles ($\bar{x}$ 18.59; SD 12.53). Commuting time ranged from 10 minutes to 1h 40 minutes, although the average was 41.45 minutes (SD 22.16). Of those sampled 86% (n=80) were married or living with a partner, 8.6% (n=8) were single, and 5.4% (n=5) separated, divorced or widowed. 25 participants had no children, whilst the remaining 68 had at least one child ($\bar{x}$ 1.52; SD 1.27, range 1-6).

When asked whether they would prefer to work straight through the turnaround period or take rest days, 24 (38.57%) of those sampled chose the latter option, whilst 11 (32.36%) chose the former. When tested at T2 only 1 participant failed to take a rest day. Here 1.1% (n=1) took 1 rest day, 4.3% (n=4) took 2, 8.6% (n=8) took 3 and 22.6% (n=21) took more than 3. The rated restfulness of days off ranged the full length of the scale from '1=very restful' to '9=definitely not restful', although the mean of 4.80 (SD 2.52) was towards the positive end of the scale.

Table 8.2b. Demographical details (frequencies) of the sample

	Permanent days	
	Frequency	%
Gender:		
Male	90	96.8
Female	3	3.2
Contract:		
Contractor	68	73.1
Employed	25	26.9
Marital Status:		
Married/living with partner	80	86.0
Single	8	8.6
Separated/divorced	5	5.4
Shiftwork Experience:		
Yes	73	78.5
No	20	21.5
Turnaround Experience		
Yes	72	77.4
No	21	22.6
Live away from home:		
Yes	48	51.6
No	45	48.4
Rest Day Preference:		
Work straight through	11	11.8
Take days off	24	25.8
Rest days taken:		
0	1	1.1
1	1	1.1
2	4	4.3
3	8	8.6
3+	21	22.6

Comparisons of T1 responses between those who had returned a questionnaire at T2 and those who had not, revealed that the two groups differed on a number of variables. Those who had completed both questionnaires were more likely to live away from home during the turnaround shifts ($t_{(96)}$=3.517, p<.001), were contracted to work fewer hours ($t_{(94)}$=3.381, p<.001), perceived their workload as heavier ($t_{(77)}$=2.280, p<.05), had a greater sleep need ($t_{(95)}$=2.454, p<.05), had more physical health problems ($t_{(94)}$=2.338, p<.05), were more introverted ($t_{(92)}$=2.401, p<.05) and perceived themselves to be at a greater risk in terms of driving home from work and safety at work ($t_{(94)}$=2.347, p<.05).

8.2.4. Materials

The structure of the survey (see Appendix 8) was designed around those used in previous studies, and thus was loosely based around the theoretical model of moderators and outcomes of shiftwork, from Folkard *et al.* (1993) and the outcomes derived from the semi-structured interviews in Chapter 5. Therefore, many of the measures used within the questionnaire were based on, or derived from, those contained within the SSI (Barton *et al.*, 1995) and the SOS (Folkard *et al.*, 1997). Because the questionnaire was to be completed during company time, every effort was made to keep it as short as possible, with the final version being 8 pages in length and divided into 6 sections. The following summarises the measures employed. Measures used in previous studies, and therefore described in depth previous to this chapter, are simply listed. Only those scales specific to the present questionnaires are discussed in detail.

Where appropriate, the psychometric properties of the scales are also summarised for comparison with previous work (see Table 8.3, Appendix 5). However, as before, due to the small number of participants in the present sample, further analysis was based on the original scoring methods, *on all scales*, to allow comparison with previous research. All factor analyses were based on a Principal Components paradigm using Varimax rotation. Only items with a factor loading of >0.30 were considered for inclusion, and where an item loaded on more than one factor, the highest loading was used for classification.

8.2.4.1. Moderator Variables

Demographic

Variables included in this category included age, gender, marital status, number of dependants, contract type, hours contracted to work each week, hours actually worked each week, years of work experience, years of shiftwork experience, locality, commuting time, whether the participant was living away from home, and the number of days they had been working the turnaround shift. Nominal variables with more than one category were recoded into dichotomous measures for analysis. Thus, for example, marital status, that contained the categories (1) married/living with partner, (2) single, (3) separated/divorced/widowed, was recoded into 'with partner' and 'without partner'.

Circadian

- Circadian Type Inventory (18 item measure)
- Time Awareness Questionnaire (38 item measure, but scored according to reduced 27 item version)
- Perceived sleep need

Personality

- EPI-12 (12 item measure)

Work-Related

- Control over specific shifts worked (single item)
- Control over specific start and finish times of the shifts worked (single item)
- Control over job pacing (single item)

Perceived workload was also included, although this was reduced to a single item. As before, this was scored on a 5 point response scale with options ranging from 1='Extremely heavy' to 5='Extremely light'.

8.2.4.2. Outcome Variables

Attitudes toward Shiftwork

- Do the advantages of shiftwork outweigh the disadvantages? (single item)
- All things being equal, would you prefer daywork to shiftwork? (single item)
- 3 main advantages and 3 main disadvantages of the turnaround shift (text responses)

Social and Domestic Interference

Analysis on the outcome measures used in Chapter 6 found the 3-item measure relating to interference with social, domestic, and non-domestic activities to produce a reliable factor structure. In lieu of the need to keep the questionnaire concise, in the present study, the three were subsumed into a single item, as used in Chapter 7. Here respondents were asked "How much does your work schedule interfere with your leisure activities, family life, and non-leisure activities?". Scoring was based on a 9 point Likert scale with response options ranging from 1='Not at all' to 9='Very much'.

Sleep, Alertness and Fatigue

- Subjective feelings of alertness (9 item measure)
- Mental Fatigue (9 item measure)
- Physical Fatigue (3 item measure)

A truncated form of the sleep scale used in the SSI was included. In Section 1 respondents were asked to report the times at which they fell asleep and woke up before, between two successive, and after their last work day, and between two successive days off. If the main sleep was supplemented with a nap, the average length of this nap was also reported. Quality of sleep information in Section 2 required responses for successive work days and successive days off only.

Risk

- Likelihood of making a minor mistake at work (single item)
- Confidence in driving home after work (single item)

Physical Health

- Physical Health Questionnaire (reduced 4 item measure)

Psychological Health

- GHQ-12 (12 item measure)
- Cognitive Somatic Anxiety Questionnaire (14 item measure)

8.2.4.3. The Follow-up Survey

Although the follow-up survey (see Appendix 8) contained many of the original scales as discussed above, additional information was also included. For demographic information, whether respondents would prefer to take rest days or work straight through the turnaround shift, the number of rest days they had taken, and how restful they perceived this time off to be, were included. Although circadian and personality measures were not taken at T2 (since the test-retest reliability of the scales used has been widely reported, e.g. Kaliterna *et al.*, 1993), the EPI-12 was included for the neuroticism scale (used as an outcome measure throughout the research). Also, because the psychometric properties of the TAQ were being assessed throughout the research, it too was repeated in the follow-up survey. However, in all subsequent analysis individual difference measures taken at T1 were used.

8.3. Results

8.3.1. Interviews

During the administering of questionnaires for T1, a total of 21 opportunistic, non-structured interviews took place with respondents who, without prompting, approached the researcher after they had completed their questionnaire. In order to gain a better understanding of the effects of the turnaround shifts, during these interviews, respondents were asked of their perception of the impact of the shift system on their lives, both in and out of work. All of those interviewed had prior turnaround experience at the site. The following section gives a brief summary of the major themes derived from these interviews.

Regardless of whether workers had been contracted in from outside the plant or were already employed by the company, all of those interviewed felt that the worst aspect of the shutdown periods were feelings of exhaustion. Most of those directly employed by the company attributed this to the fact that they had been used to working a rotating pattern with fixed time off, whilst during turnaround shifts "*work is more intense and seems like a solid block with long hours*"$_{(no.\ 5)}$. In contrast, the majority of contractors stated the greatest contributor to their tiredness to be travelling to, or having to find, accommodation at the end of the working day. Indeed, one interviewee working the night shift explained how nightworkers living in guesthouses found it extremely difficult to sleep during the day as they had limited access to their rooms, often being forced out whilst they were cleaned. For dayworkers the major complaint was having to share a room with others, leading to feelings that "*you never get a minute's peace, and feel like you're always at work*" *(no. 11)*.

Social and domestic interference was also high on the list of concerns amongst all those interviewed. For contractors, living away from home was again the main reason: "*my time outside of work is affected alot because my home is 260 miles away*" *(no. 2)*. For employed personnel used to working a rotating shift pattern, the main feeling was having to put their social life on hold for a month: "*I've just bought a boat to do up as a hobby but because I knew I was working the turnaround, I've locked it away, I won't be even thinking about it for a month*" *(no. 1)* or having to change their routines: "*it's the discipline of having to go to bed at the same time every night that affects me*" *(no. 6)*.

However, the overwhelming subject of all interviews were the regulations regarding what many termed 'forced rest days', and was a subject on which both permanent and contracted personnel agreed strongly. This was underlined with remarks such as "*forced rest days are of no use*" *(no. 21)* and "*they're just a waste, they're supposed to be recovery days, but they can't even be used for that*" *(no. 7)*. Fifteen out of the twenty-one interviewed felt that they would prefer to work longer hours in order to have more days off in a row: "*I could have one day as recovery, the next as a normal day, and the next as getting back into the shiftworking mode again, at least then I feel like some of it's my own*" *(no. 9)*.

For contractors, living away from home again arose as a problem when taking rest days, sharing the view that they would prefer to work straight through the turnaround period without a rest day, since for most "*it doesn't give you enough time to go back and see your family. For me it's a 10 hour journey there, only to spend a couple of hours with them before I have to leave to get back in time*" *(no. 15)*. For those who choose not to go home during this time, the popular view was that "*there's nothing to do for contractors in a place like this. We end up spending a day's worth of money when we could be earning*" *(no. 12)*, with another stating that "*more than once I've not been allowed back into my lodgings in the daytime, and had to walk around, trying to find things to do. It can really get you down*" *(no. 19)*.

Despite such strong feelings about the way in which their work was organised during shutdown periods, only 1 out of those interviewed would not volunteer to work them again. For the remainder only one reason was given: money, supported by remarks such as "*better money is reason enough to get involved in turnaround shifts*" *(no. 17)* and "*although I have to work more* *hours and get fewer days off, I keep volunteering to work them purely for the extra money involved*" *(no. 1)*.

Thus, as in Chapter 5, the shiftworkers involved in the present study were keen to share their concerns over their working patterns and how it affected other aspects of their lives. However, since such an insight was based on only a small subset of participants the following section investigates whether such concerns were true of the cohort as a whole.

8.3.2. Statistical Analysis

In the first instance paired samples t-tests between measures at T1 and T2 were performed to examine whether outcome measures had been moderated by time on shift. Multivariate analysis in the form of regressions were then performed to investigate the predictive power of modifiers with the influence of covariates both uncontrolled and controlled. However, due to the large number of variables derived from the questionnaires, both outcomes and modifiers were first subjected to correlational and/or factor analysis. The following sections discuss the rationale behind doing so and the findings that resulted.

8.3.2.1. Reduction of Outcome Variables

Reduction of outcome variables in previous chapters was based on exploratory factor analysis in an attempt to derive the underlying dimensions within the sets of variables employed. However, due to the small cohort size involved in the present study confirmatory factor analysis using the factor structures derived from both Chapter 6 and 7 were employed since these were based on larger sample sizes. Because of insufficient data at T2, factor analysis was not performed separately in an effort to avoid the increased risk of obtaining unreliable factor structures. As before, where scales had been derived from individual items (e.g., psychological health from the GHQ-12), the scale, rather than the individual component items, was used. Where factors were constructed, the standardised (z transformation) scores from the component items were used in creating the dimensions.

In an attempt to explore whether on-shift alertness was more strongly associated with the psychological health and sleep factor (as in Chapter 6) or a perceived risk factor (as in Chapter 7) factor analysis was run on both possibilities. When forced into a one factor solution with quality of sleep during work days, and rest days, cognitive and physical fatigue, psychological health, cognitive and somatic anxiety and neuroticism, this yielded a factor that accounted for 53.30% of the variance (eigenvalue 4.797). Loadings ranged from -.436 through to +.857 with alertness being the lowest overall. The low loading was further reflected in reliability analysis with the exclusion of alertness being the only variable to increase the alpha coefficient (from .8646 to .8918).

In the second part of the analysis the 3 items comprising the 'Alertness and Safety' factor derived in Chapter 7, 'the likelihood of making a minor mistake at work', 'confidence in driving home after work' and 'on-shift alertness', were forced into a one factor solution. Accounting for 52.45% of the variance and with an eigenvalue of 1.574, loadings were high, ranging from +.683 (alertness) to +.770 (likelihood of making a minor mistake). Reliability analysis yielded a low scale alpha at .5412, with no single item reducing this value.

According to these results, although on-shift alertness loaded on psychological health and sleep it lowered the overall scale reliability, whereas, although the alpha coefficient for the risk factor was comparatively lower, alertness nevertheless contributed to the total reliability value. Thus, the 'Psychological Health and Sleep' factor used in further analysis comprised quality of sleep during work days, quality of sleep during rest days, cognitive and physical fatigue, psychological health, cognitive and somatic anxiety and neuroticism and had a high scale alpha of .89, whilst the factor comprising the two risk items and on shift alertness had a lower alpha coefficient of just .54. However, to further explore the dimension, the latter factor structure was retained and named 'Alertness and Safety'.

Interestingly, when the psychological health and sleep, risk components, and on-shift alertness were entered into a single factor analysis a different pattern of results emerged. Although 2 factors were derived, the first accounted for 49.22% of the variance (eigenvalue 5.414) and contained the likelihood of making a minor mistake, quality of sleep during rest days, cognitive fatigue, GHQ-12 scores, cognitive and somatic anxiety and neuroticism, all of which had relatively high loadings. Reliability analysis showed this factor to have good internal consistency at .8877, with only the risk factor resulting in a decrease. The second factor comprised the items: confidence in driving home from work, quality of sleep during work days, physical fatigue and on-shift alertness. As above, the reliability of this factor was lower at .5965, although here no single item reduced the total scale alpha. Although these structures were both interpretable and had good reliability, such analysis was based on a smaller sample than those used previously. It should also be noted that there was a large amount of missing data on the alertness scale which has obvious implications for the reliability of the trends found. Therefore, for this reason, the confirmatory factor structures discussed above were retained.

Since a reduced version of the Physical Health Questionnaire had been used in the present study, the factor structure gained from Chapter 7 was employed. When forced into a single solution, the four subscales accounted for 47.48% of the total variance (eigenvalue 1.899), where loadings ranged from .529 to .783. When subjected to Cronbach alpha, the total scale alpha of .6108 was increased with the exclusion of 'musculoskeletal pain', yielding a coefficient of .6228. Despite this, the factor structure was retained and named "Physical Health".

Both attitude towards shiftwork measures and the reduced item social and domestic interference measure were treated independently in subsequent analysis to allow comparison with previous studies. In terms of sleep duration, at T1, the number of hours sleep before the first shift and between two successive shifts were appropriate, whilst at T2, the number of hours sleep between two successive shifts, after the last shift, and between two successive rest days were appropriate. Therefore, these were also treated as separate variables in further analysis.

The strength of association amongst outcome variables was further explored by correlating the factors against each other. As can be seen in Table 8.4 only 1 outcome measure (whether the advantages of shiftwork outweighed the disadvantages when tested at T1) failed to correlate with any other included in the analysis. Indeed this was also the only variable found not to correlate across both time points, with the remaining measures correlating positively in all cases (with coefficients ranging from .413 to .678). Interestingly at T2, whether the advantages outweighed the disadvantages correlated with social and domestic interference at both T1 and T2, where in both cases a negative value suggested that greater social and domestic impairment was related to fewer advantages, supporting previous chapters. In comparison the second attitude measure, T1 preference for daywork over shifts, showed a positive correlation with T1 social and domestic life only, suggesting that more impairment was associated with a preference for days. Furthermore, a preference for daywork at both T1 and T2 was the outcome measure most strongly and consistently linked to sleep, being positively associated with sleep length at baseline and follow up. In all cases a preference for days was associated with longer sleep.

A definite clustering of significant correlations can also be seen amongst the remaining outcome variables. T1 social and domestic interference was positively associated with all other measures apart from physical health at T1, suggesting that greater impairment was associated with greater perceived risk concerning alertness and safety, more physical health symptoms (T2 only) and greater problems relating to psychological health and sleep quality. T2 social and domestic interference correlated with T2 outcomes only, with relationships being in the same direction as those mentioned above. Alertness and safety was consistently and highly linked to the two health measures. Such a relationship is perhaps not surprising given that alertness loaded on the psychological health and sleep factor, as in previous chapters. Furthermore, as expected the two health measures themselves were highly correlated at both time points.

Table 8.4. Correlations between outcome variables amongst oil refinery workers

	Attitude 1	Attitude 2	Prefer 1	Prefer 2	Social 1	Social 2	Safety 1	Safety 2	Physical 1	Physical 2	Psych 1	Psych 2	Sleep before 1st shift 1	Sleep between shifts 1	Sleep between rest 1	Sleep between shifts 2	Sleep after last shifts 2
Attitude 1	-																
Attitude 2	.109	-															
Preference 1	.008	-.061	-														
Preference 2	-.040	-.155	**.678*****	-													
Social 1	-.094	**-.416***	**.242***	.176	-												
Social 2	.140	**-.478****	-.147	-.109	**.413***	-											
Safety 1	-.029	-.248	.025	-.028	**.306****	.200	-										
Safety 2	.220	-.307	.034	.011	**.340***	**.519*****	**.541*****	-									
Physical 1	-.009	-.300	.021	.045	.191	.010	**.380*****	.264	-								
Physical 2	.114	-.235	.296	.184	**.477****	**.338***	**.414***	**.586*****	**.441****	-							
Psych 1	-.013	-.201	.075	-.060	**.277****	.307	**.577*****	**.626*****	**.532*****	**.468****	-						
Psych 2	.015	-.327	.098	-.049	**.319****	**.409***	**.420*****	**.658*****	**.307****	**.548*****	**.655*****	-					
Sleep before 1st shift 1	-.102	**-.345***	.097	.341	-.024	.023	-.011	.094	.105	.226	-.036	-.020	-				
Sleep between shifts 1	-.037	-.221	**.222***	.250	.081	.021	.023	.209	.135	.133	.039	.090	**.644*****	-			
Sleep between rest 1	.191	-.251	**.295****	**.363***	**.308****	.022	.106	.034	.105	.144	.042	.005	**.271***	**.341****	-		
Sleep between shifts 2	-.042	-.049	**.496****	**.404***	.046	-.007	-.001	.110	.242	.269	.099	.053	**.408***	**.448****	.205	-	
Sleep after last shift 2	.249	-.178	**.347***	**.375***	.102	.091	.024	**.445****	.052	.314	.079	.190	.202	.263	.310	**.408***	-
Sleep between rest 2	.259	-.186	**.455***	**.498****	.185	.018	.159	**.423***	.149	.304	.181	.311	.151	.338	**.591*****	.277	**.882*****

*** p<.001; ** p<.01; * p<.05
Attitude='Advantages outweigh disadvantages'; Prefer= 'Preference for daywork over shifts'; Social='Social and domestic interference'; Safety='Alertness and safety'; Physical='Physical Health'; Psych='Psychological Health and sleep'.

The highest correlation overall was seen amongst sleep length items. Here sleep between rest days at T2 correlated at .882 ($p<.001$) with sleep after the final shift at T2.

In summary, correlations between outcome variables showed that relationships generally held over time, psychological health and sleep at T1 correlated with T1 social and domestic life, T1 alertness and safety and T1 physical health, for example. The same relationships were noted with T2 results. However, in other instances this was not the case. For example, whilst physical health at T2 correlated with T2 social and domestic interference and alertness and safety, at T1 only the latter relationship achieved significance.

8.3.2.2. Reduction of Modifier Variables

As with previous chapters, due to the nature of regression analysis, the ratio of moderator variables to outcome variables posed a problem. Therefore, as before, in an attempt to reduce their total number, relationships between modifiers were examined through Pearson's correlations. Table 8.5 shows the remaining variables used in the analysis.

As expected a strong relationship between 'age' and 'number of years work experience' was found ($r_{(91)}=.814$, $p<.001$), leading to the exclusion of the latter. A strong relationship also existed between the variables 'employed/contractor' and 'are you living away from home' ($r_{(98)}=-.501$, $p<.001$) since all contractors, by nature of their job, lived in temporary accommodation during shutdown periods. Since a number of differences between the groups had already been identified throughout the interviews this was taken to be the stronger variable and so only 'contract type' was retained. Furthermore, because only those participants who had previous experience of working shifts were able to give a response as to the length of this experience, only the former variable was used in further analysis.

Table 8.5. Modifier variables used in further analysis

Demographic	Circadian/Personality	Work related
Age	Perceived sleep need	Control over job pacing
Gender	Morningness (TAQ)	Control over shifts
No. of children	Strength of preferences	Perceived workload
Marital status	Time awareness	
Contract	Languidity/Vigorousness	
Shiftwork experience	Flexibility/Rigidity	
Locality	Extroversion/Introversion	

In terms of the work related variables, as expected from previous chapters the correlation between 'control over the specific shift worked' and 'control over the specific start and finish times of the shifts worked' was high and positive ($r_{(98)}=.499$, $p<.001$). Therefore scores on each were z-standardised and summed to give a global 'control' measure (α = .65). Perceived control over the pacing of the job and workload failed to correlate highly with any of the work related factors, nor the remaining modifier variables and were retained in their existing form.

8.3.2.3. Effect of Time

The degree of participants' adaptation to the shift over time was analysed by means of paired samples t-tests of the outcome variables, comparing responses at T1 with those obtained at T2. Descriptive statistics are presented in Table 8.6, showing values for both the factors (where derived) and the component items.

Table 8.6. Descriptive statistics of outcome variables by shift and time

	Day Shift				
	T1		T2		
	$\bar{x}$	(SD)	$\bar{x}$	(SD)	t
Advantages outweigh Disadvantages	3.00	(1.15)	2.79	(1.20)	0.764
Preference for Days over Shifts	4.33	(1.05)	3.94	(1.34)	**2.267***
Social and Domestic Interference	3.97	(1.40)	4.09	(1.12)	0.487
Psychological Health and Sleep	-0.35	(5.64)	-0.10	(3.44)	0.552
Sleep quality on work days	16.26	(3.71)	21.18	(4.05)	**8.636*****
Sleep quality on rest days	14.59	(3.43)	20.49	(3.39)	**11.483*****
Cognitive Fatigue	14.06	(5.36)	15.63	(6.36)	0.212
Physical Fatigue	7.42	(2.26)	8.79	(2.59)	**2.193***
GHQ-12	22.05	(3.31)	22.88	(3.77)	1.118
Cognitive Anxiety	10.37	(4.17)	10.62	(3.85)	0.188
Somatic Anxiety	10.20	(3.39)	11.06	(3.14)	**2.674***
Neuroticism	10.60	(2.99)	10.60	(2.99)	-
Physical Health	0.59	(2.75)	0.12	(2.50)	1.005
Gastrointestinal health	2.00	(0.97)	1.80	(0.99)	0.960
Minor infections	2.11	(1.25)	2.40	(1.31)	0.980
Cardiovascular health	1.29	(0.79)	1.43	(0.88)	1.712
Musculoskeletal pain	2.37	(1.26)	2.69	(1.41)	1.510
Alertness and Safety	0.33	(2.06)	0.05	(2.44)	1.029
Likelihood of making a mistake at work	3.31	(1.45)	3.51	(1.56)	0.894
Confidence in driving home	2.94	(1.30)	3.00	(1.74)	0.206
Alertness	6.77	(1.17)	6.79	(1.39)	0.429
Sleep Duration:					
Before first work day	7.23	(1.01)	-	-	-
Between successive work days	7.45	(0.84)	7.66	(0.79)	1.407
After last work day	-	-	8.94	(1.68)	-
Between successive rest days	8.63	(1.60)	8.43	(1.46)	0.783

***p<.001; ** p<.01; * p<.05

In terms of attitudes towards shiftwork, the perceived advantages measure indicated a less favourable response at T2, whilst on the preference for daywork over shifts item, a more favourable response was elicited ($t_{(32)}$=2.267, p<.05). The level of social and domestic disruption was also rated as worse when tested at the end of the turnaround phase, but failed to reach significance. Whilst 'Psychological Health and Sleep' showed a worsening over time, only the difference between scores on sleep quality during work days ($t_{(30)}=8.636$, $p<.01$), rest days ($t_{(25)}=11.483$, $p<.001$), physical fatigue ($t_{(33)}=2.193$, $p<.05$) and somatic anxiety ($t_{(33)}=2.674$, $p<.05$) were found to be significantly worse at T2. A similar picture was also seen for 'Alertness and Safety' where all 3 components showed a worsening of problems over time, although none were found to be significantly different. Scores derived for physical health showed mixed results, for whilst participants perceived themselves to suffer fewer gastrointestinal symptoms at T2, scores on the three remaining subscales were in the opposite direction, showing more symptoms of cardiovascular complaints, minor infections and musculoskeletal pain. No comparisons were found to be significantly different. Despite this, physical health and a preference for shiftwork over days were the only outcome variables to show an improvement between baseline and follow-up.

Perceived Advantages and Disadvantages of Shiftwork

In order to examine the perceived advantages and disadvantages of shiftwork in a manner uncontaminated by the specific wording of questions, respondents were given three text boxes and asked "What are the three main advantages of your shift system for you?". This was repeated for the perceived disadvantages. These responses were classified into major domains, with no attempt to match outcome variables employed in the survey. The findings are illustrated in Figures 8.1 and 8.2.

A clear distinction between the advantages and disadvantages is evident in Figure 8.1. In terms of the advantages, items classified in the 'other' category, such as shift characteristics and 'regular employment', dominated all responses, although financial rewards were also widely reported. In contrast few workers mentioned rewards related to sleep, social and leisure time, or family and domestic domains. Shift characteristics and job security also dominated the perceived disadvantages, although here adverse effects on social and leisure, family and domestic, and sleep domains were more prominent. Commuting also received more attention in this category.

These trends were emphasised at T2, where again financial rewards and comments contained in the 'other category' predominated the perceived advantages. Positive effects on sleep and social and leisure events were also represented here. Likewise, the trends in perceived disadvantages supported those found at T1, with adverse effects to family and domestic life being the strongest disadvantage overall.

Figure 8.1. Perceived advantages and disadvantages at T1 amongst oil refinery workers

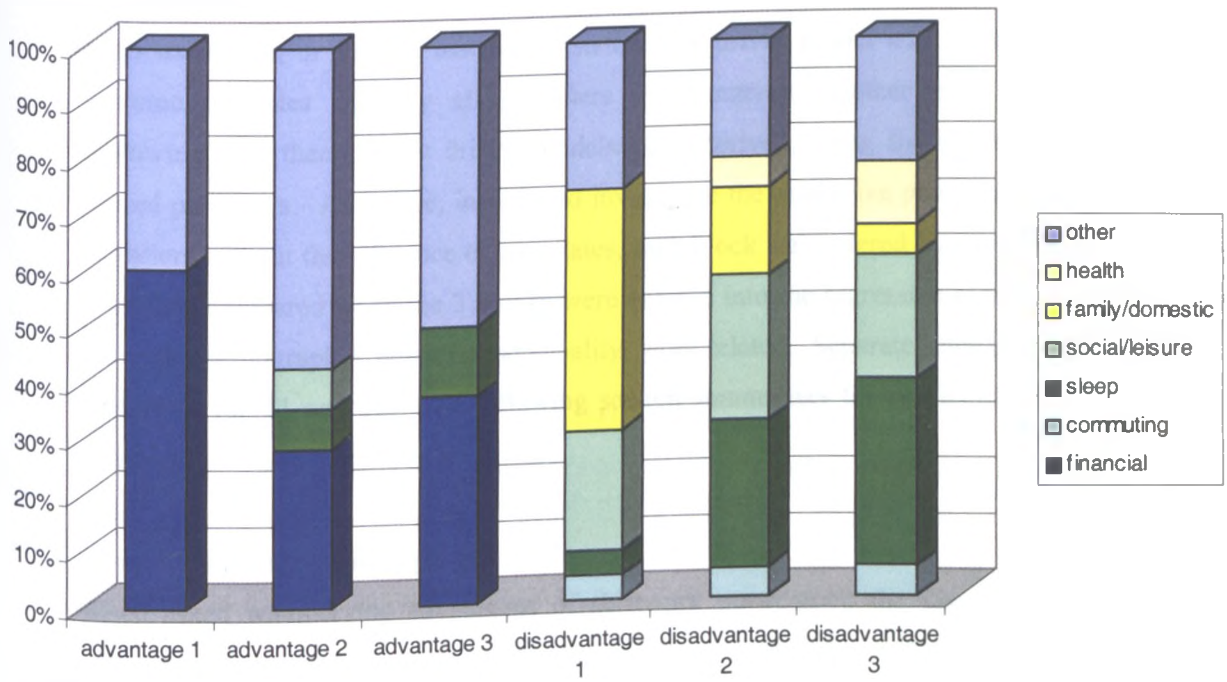
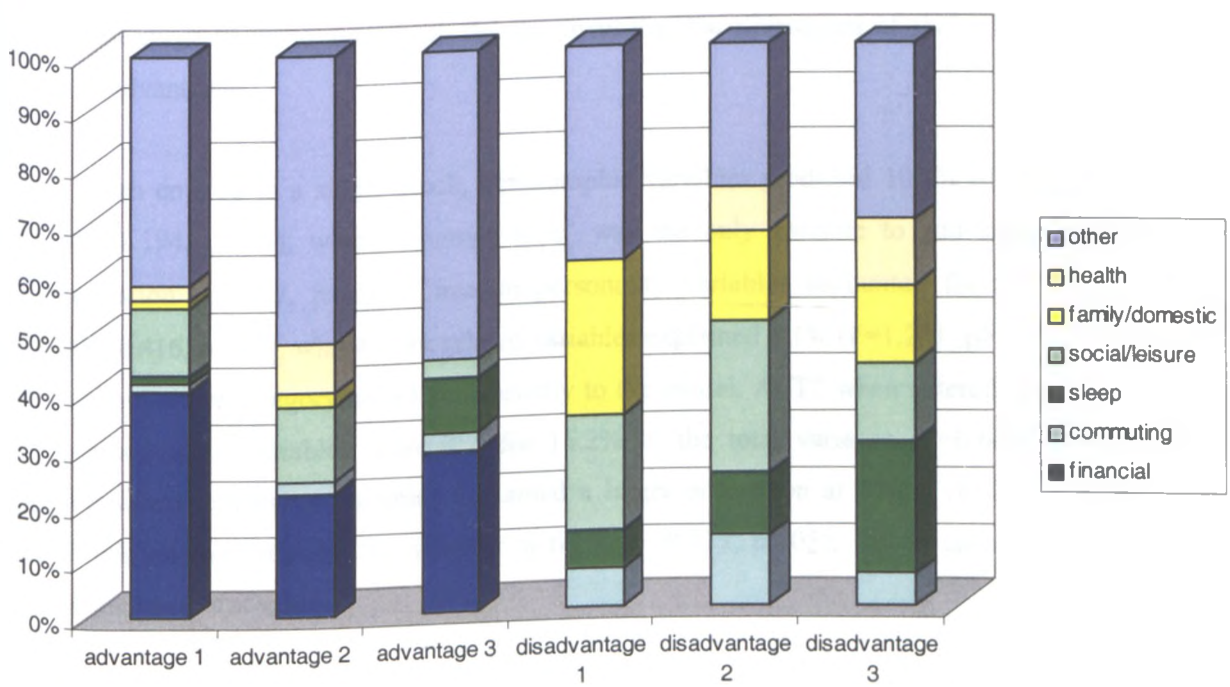


Figure 8.2. Perceived advantages and disadvantages at T2 amongst oil refinery workers



8.3.2.4. Multivariate Analysis

In order to examine the predictive validity of the modifier variables, a series of regression analyses were performed, where modifiers were treated as independent variables with each of the outcomes being entered in turn as the dependent variables. Following the same strategy as previous studies, in the first instance, a statistically driven model was derived for each of the outcome variables whereby all modifiers were entered together in a stepwise method. Following this, theoretically driven models were derived, using the modifiers as blocks of related predictors. As before, in order to investigate the predictive power of each category of modifiers without the influence of covariates, each block was entered on its own. These results were then compared when the 3 blocks were entered into the regression model sequentially, in the order: demographic, circadian/personality, work related. Separate regression analyses were performed for T1 and T2. The following section summarises the results of this analysis (see Tables 8.7, 8.8 and 8.9, below).

Perceived Advantages of Shiftwork

When asked whether the advantages of shiftwork outweighed the disadvantages, only one predictor emerged at T1. Here, 'contract type' accounted for 6.4% of the total variance ($F=4.344$, $p<.05$), with a β-weight of .254 ($p<.05$), suggesting that those directly employed by the company were more likely than contractors to have a favourable attitude towards shiftwork. At T2 only one predictor, that of 'flexibility' was extracted. This accounted for 20.8% of the total variance ($F=7.352$, $p<.05$), with a β-weight of .456 ($p<.05$) suggesting that flexible types were more likely to agree with the statement that the advantages of shiftwork outweighed the disadvantages.

When entered as a single block, demographic variables predicted 10.9% of the total variance ($F=1.194$, $p>.05$), where 'contract type' was the only variable to add significantly to the equation ($\beta=.287$, $p<.05$). Circadian/personality variables accounted for the least at 3.9% ($F=0.416$, $p>.05$), whilst work related variables explained 5.1% ($F=1.231$, $p>.05$). No variables within either category added significantly to the model. At T2 when entered as a single block, demographic variables accounted for 16.2% of the total variance ($F=0.665$, $p>.05$), whilst circadian/personality variables explained a larger proportion at 39.1% ($F=2.295$, $p>.05$), and work related variables the smallest at 6.2% ($F=0.577$, $p>.05$). In no case was a significant equation extracted.

Table 8.7. Summary statistics for stepwise regression amongst oil refinery workers

		Predictors	R^2 change	F change	df	β
Advantages outweigh Disadvantages:						
	T1	Contract type	.064	4.344*	1,63	.254*
	T2	Flexibility/Rigidity	.208	7.352*	1,28	.456*
Preference for Daywork over Shifts:						
	T1	Perceived sleep need	.093	6.498*	1,63	.306*
	T2	Locality	.241	8.555**	1,27	.550***
		Shiftwork experience	.241	12.051**	1,26	-.464**
		Flexibility/Rigidity	.082	4.687*	1,25	-.288*
Social & Domestic Disruption:						
	T1	Perceived sleep need	.129	9.340**	1,63	.359**
	T2	No predictors	-	-	-	-
Psychological Health & Sleep:						
	T1	Languidity/Vigorousness	.165	12.455***	1,63	.266*
		Control over job pacing	.095	7.953**	1,62	-.282*
		Flexibility/Rigidity	.070	6.406*	1,61	-.278*
	T2	Languidity/Vigorousness	.131	9.493**	1,28	.362**
Physical Health:						
	T1	Flexibility/Rigidity	.089	6.137*	1,63	-.298*
	T2	Control over job pacing	.224	8.101**	1,28	-.466**
		Contract type	.191	8.796**	1,27	.382*
		Perceived sleep need	.084	4.357*	1,26	.295*
Alertness and Safety:						
	T1	Languidity/Vigorousness	.178	13.612***	1,63	.337**
		Extroversion	.081	6.782*	1,62	-.241*
		Control over job pacing	.055	4.899*	1,61	-.245*
	T2	Contract type	.254	9.551**	1,28	.440**
		Perceived sleep need	.116	4.963*	1,27	.346*
Sleep Length:						
Before 1st work day						
	T1	Perceived sleep need	.106	7.433**	1,63	.300*
		Strength of preferences	.064	4.814*	1,62	-.255*
Between successive work days						
	T1	Perceived sleep need	.246	20.600***	1,63	.458***
		Morningness	.056	4.981*	1,62	-.240*
	T2	No predictors	-	-	-	-
After last work day						
	T2	Number of children	.180	5.720*	1,26	-.495***
		Locality	.124	4.477*	1,25	.523***
		Shiftwork experience	.127	5.339*	1,24	-.304**
		Control over job pacing	.094	4.528*	1,23	-.413***
		Extroversion	.123	7.646*	1,22	.394**
		Control over shifts	.074	5.601*	1,21	.275*
		Marital status	.063	5.808*	1,20	-.270*
Between successive rest days						
	T2	Languidity/Vigorousness	.182	5.357*	1,24	.457**
		Number of dependants	.167	5.907*	1,23	-.421**
		Control over shifts	.117	4.824*	1,22	.357*
		Strength of preferences	.095	4.543*	1,21	.315*
		Gender	.080	4.446*	1,20	-.286*

*** p<.001; ** p<.01; * p<.05

Table 8.8. Summary statistics for hierarchical regression (individual blocks) amongst oil refinery workers

		Demographic		Circadian/Personality		Work related	
		R^2	F	R^2	F	R^2	F
Advantages outweigh Disadvantages:							
	T1	**.109**	**1.194**	.039	0.416	.051	1.231
	T2	.162	0.665	**.391**	**2.295**	.062	0.577
Preference for Daywork over Shifts:							
	T1	.111	1.213	**.129**	**1.527**	.036	0.864
	T2	**.540**	**3.863****	.324	1.643	.129	1.234
Social & Domestic Disruption:							
	T1	.023	0.230	**.210**	**2.740***	.003	0.067
	T2	.181	0.757	**.198**	**0.881**	.177	1.860
Psychological Health & Sleep:							
	T1	.119	1.311	**.293**	**4.253*****	.195	5.652**
	T2	.157	1.810	**.210**	**2.732***	.082	2.054
Physical Health:							
	T1	.074	0.773	**.140**	**1.681**	.078	1.949
	T2	.259	1.201	**.274**	**1.345**	.254	2.949
Alertness and Safety:							
	T1	.104	1.131	**.317**	**4.766*****	.159	4.338**
	T2	**.416**	**2.446***	.314	1.635	.173	1.816
Sleep Length:							
Before 1st work day							
	T1	.073	0.752	**.222**	**2.893****	.022	0.490
Between successive work days							
	T1	.024	0.230	**.362**	**5.675*****	.027	0.604
	T2	**.287**	**1.325**	.269	1.261	.040	0.344
After last work day							
	T2	**.669**	**6.352*****	.177	0.705	.086	0.756
Between successive rest days							
	T2	**.457**	**2.288**	.329	1.399	.109	0.900

*** $p<.001$; ** $p<.01$; * $p<.05$

Table 8.9. Summary statistics for hierarchical regression (sequentially) amongst oil refinery workers

	Demographic		Circadian/Personality		Work related	
	R^2	F	R^2 change	F change	R^2 change	F change
Advantages outweigh Disadvantages:						
T1	.109	1.001	.025	0.206	.047	0.899
T2	.162	0.609	**.540**	**3.886***	.027	0.403
Preference for Daywork over Shifts:						
T1	.111	1.016	.113	1.040	.058	1.269
T2	.540	3.527*	**.272**	**2.888***	**.104**	**4.564***
Social & Domestic Disruption:						
T1	.023	0.193	.228	2.170	.018	0.397
T2	.181	0.693	.157	0.507	.105	0.757
Psychological Health & Sleep:						
T1	.119	1.099	**.254**	**2.886***	.083	2.386
T2	.157	1.518	.177	1.892	.011	0.268
Physical Health:						
T1	.074	0.648	.118	1.047	.044	0.909
T2	.259	1.101	.185	0.713	.189	2.068
Alertness and Safety:						
T1	.104	0.948	**.272**	**3.117****	.052	1.436
T2	.416	2.242	.255	1.664	.035	0.482
Sleep Length:						
Before 1st work day						
T1	.073	0.640	.210	2.086	.014	0.305
Between successive work days						
T1	.024	0.198	**.363**	**4.229*****	.019	0.491
T2	.287	1.209	.166	0.605	.075	0.584
After last work day						
T2	.669	5.774***	.101	0.817	**.164**	**8.340****
Between successive rest days						
T2	.457	2.168	.293	1.844	.127	2.744

*** p<.001; ** p<.01; * p<.05

As shown in Table 8.9 hierarchical multiple regression showed that, after the entry of demographic variables in step 1, neither circadian/personality variables entered in step 2 (R^2 change=.025, F change=0.206, p>.05), nor work related variables in step 3 (R^2 change=.047, F change=0.899, p>.05) significantly improved the prediction of the perceived advantages of shiftwork. At T2, after the entry of demographic variables in step 1, only circadian/personality variables in step 2 increased the predictive power of the model (R^2 change=.540, F change=3.886, p<.05). Examination of the β statistics indicated that both 'age' (β=-.498,

$p<.05$) and 'contract type' ($\beta=-.355$, $p<.05$) reached significance. The addition of work related variables in step 3 failed to show an improvement (R^2 change=.027, F change=0.403, $p>.05$), although, in the final solution both 'age' and 'flexibility' achieved significant β-values.

Summary

Thus, taken together the results suggest that, of the categories of modifiers included in the analysis, at T1, demographic variables were the strongest in predicting whether the advantages of shiftwork outweighed the disadvantages. This conclusion is supported by the fact that demographic variables contributed the highest proportion of variance when entered by themselves, and decreased the predictive power of both circadian/personality and work related modifiers when combined in hierarchical regression modelling. However, at T2, circadian/personality variables were the stronger category, contributing the highest proportion of variance when tested alone, and also showing an increase (31% to 44.6%) when entered in step 2 in the hierarchical model. This suggests that demographic variables, at this stage, had little mediating impact on circadian/personality measures. In support of the prediction, the fact that work related variables failed to improve the predictive power of the model suggested that, when taken together, demographic and circadian/personality variables had a mediating impact at follow-up.

Preference for Daywork over Shifts

In terms of a preference for daywork over shiftwork, again few predictors emerged. At T1, 'perceived sleep need' by itself accounted for just 9.3% of the variance (F=6.498, $p<.05$), where daywork was preferred amongst long sleepers ($\beta=.306$, $p<.05$). At T2, three predictors accounted for a much larger proportion of the variance, 56.4% in total. The strongest was 'locality' (R^2 change=.241, F=8.555, $p<.01$) where those living further away from the site preferred daywork to shifts ($\beta=.550$, $p<.001$). 'Shiftwork experience' contributed the same proportion of variance (R^2 change=.24.1, F change=12.051, $p<.01$), but had a lower β-value of -.464 ($p<.05$), perhaps supporting the healthy shiftworker effect, with greater experience being associated with a preference for shifts. Finally, as with the perceived advantages, 'flexibility' was extracted, predicting 8.2% of the variance (F change=4.687, $p<.05$; $\beta=.-.288$, $p<.05$).

At T1, when entered as a single block, demographic variables predicted 11.1% of the total variance (F=1.213, $p>.05$), with only 'shiftwork experience' adding to the equation ($\beta=-.275$, $p<.05$). Although circadian/personality variables accounted for 12.9% (F=1.527 $p>.05$), this did not result in a significant solution. Inspection of the β-weights supported the stepwise model, with 'perceived sleep need' being the only modifier within this category to reach significance

(β=.291, p<.05). Work related variables accounted for the smallest amount of variance (R^2=.036, F=0.864, p>.05), with no single variable adding significantly to the equation. Hierarchical multiple regression showed that, after the entry of demographic variables in step 1, neither circadian/personality (R^2 change=.113, F change=1.040, p>.05) nor work related variables (R^2 change=.058, F change=1.269, p>.05) improved the prediction of a preference for days over shifts. No single variable in the final model significantly added to the equation.

At T2, a similar picture arose, with demographic variables predicting the highest proportion of variance, accounting for 54% (F=3.863, p<.01). Inspection of the β-weights supported the stepwise model, where both 'locality' (β=.629, p<.001) and 'shiftwork experience' (β=-.460, p<.01) added significantly to the solution. Circadian/personality variables entered as a single block accounted for 32.4% (F=1.643, p>.05), with work related variables accounting for 12.9% (F=1.234, p>.05). No single variable added to the equation in either case.

Hierarchical regression at T2 showed a contrasting picture, with both circadian/personality (R^2 change=.272, F change=2.888) and work related variables (R^2 change=.104, F change=4.564) adding to the prediction of a preference for working days. However, in the final model, 7 variables were significant, 'locality', 'languidity', 'shiftwork experience', 'morningness', 'perceived workload', 'control over shifts' and 'time awareness', listed from most to least important.

Summary

The fact that the amount of variance explained by circadian/personality modifiers decreased at both T1 and T2 once the potential effects of demographic variables had been held constant, suggests that the former had some mediating impact on the latter, as hypothesised. In contrast, once the potential effects of demographic and circadian/personality variables had been controlled for, the influence of work related variables showed an increase, suggesting that, when taken together, the former two categories had little mediating impact. Overall, at T1, circadian variables were found to be the most important, whilst at T2, demographic variables were the most powerful in predicting the preference for daywork over shiftwork.

Social & Domestic Disruption

In terms of social and domestic disruption, only 1 modifier, that of 'perceived sleep need' was extracted at T1. Accounting for a relatively large 12.9% of the total variance (F=9.340, p<.01), longer sleepers reported more interference (β=.359, p<.01). No predictors emerged at T2. When entered as a single block, demographic variables predicted a very small proportion of the variance at T1 (R^2=.023, F=.230, p>.05), whereas, in contrast, circadian/personality variables predicted 21% (F =2.740, p<.05). Within this category 'lower perceived sleep need' (β=.256, p<.05), 'languidity' (β=.289, p<.05) and 'morningness' (β=.271, p<.05) were associated with greater interference. Work related variables contributed the least amount of unique variance at just 0.3% (F=.067, p>.05) with no single variable adding significantly to the equation.

Hierarchical analysis failed to support this, where after the entry of demographic variables, neither circadian/personality (R^2 change=.228, F change=2.170, p>.05) nor work related modifiers (R^2 change=.018, F change=0.397, p>.05) added significantly to the prediction of interference. Inspection of the β-weights in the final model showed no single variable to add significantly to the equation, although 'morningness', 'languidity' and 'perceived sleep need' all approached significance.

At T2, when entered as individual blocks, all 3 categories of modifiers accounted for similar proportions of the variance. Demographic variables contributed 18.1% (F=0.757, p>.05), circadian/personality variables 19.8% (F=0.881, p>.05), and work related variables 17.7% (F=1.860, p>.05). However, no single variable added significantly to the equation in any case. The hierarchical model showed similar results. After the entry of demographic variables in step 1, circadian/personality variables in step 2 failed to add significantly to the prediction of social and domestic interference despite contributing a further 15.7% to the total variance (F change=0.507, p>.05) whilst work related variables added in step 3, contributed a further 10.5% (F change=0.757, p>.05). None of the modifiers yielded significant β-weights in the final model.

Summary

In summary at T1, holding demographic variables constant resulted in the proportion of variance explained by circadian/personality variables to increase from 21% when tested in isolation, to 22.8% when tested in the hierarchical model. This suggests that demographic variables had little mediating influence over modifiers within the second category. The opposite was true at T2, where the predictive power of circadian/personality modifiers decreased by 0.41%. In the same way, at T1 the influence of work related variables increased in the hierarchical analysis, indicating the strength of variables within this category, whilst at T2, the predictive power of work related variables decreased by over 5%. Thus, on the balance of evidence presented here, circadian/personality characteristics had the greatest predictive power. Whilst the same was true at T2, the fact that the power of circadian/personality variables decreased when demographic variables had been partialled out suggests that the latter strengthened the former to a degree and thus both categories were important.

Psychological Health & Sleep

When all modifiers were entered in a stepwise model, 3 were extracted as predictors of psychological health and sleep at T1, that between them accounted for 33% of the total variance. 'Languidity' accounted for the highest proportion, explaining 16.5% of this total ($F=12.455$, $p<.001$), with a positive β-weight ($\beta=.266$, $p<.05$) indicating that difficulty in overcoming drowsiness was associated with more problems. 'Control over job pacing' accounted for a further 9.5% of the variance (F change=7.953, $p<.01$) with a negative β-value suggesting that more problems were experienced by those who perceived themselves to have less control ($\beta=-.282$, $p<.05$). 'Flexibility' was extracted as the final predictor. Accounting for 7% of the total variance (F change=6.406, $p<.05$), flexibility was associated with fewer problems ($\beta=-.278$, $p<.05$). In contrast, only one modifier was extracted as a predictor at T2. Here 'languidity' accounted for 13.1% of the total variance ($F=9.493$, $p<.01$) with a positive β-weight suggesting that, as at T1, languid individuals suffered more problems ($\beta=.362$, $p<.05$).

When entered on their own, demographic variables predicted 19.9% of the total variance at T1 ($F=1.311$, $p>.05$). Circadian/personality variables entered together as a single block significantly predicted 29.3% ($F=4.253$, $p<.001$), with 'languidity' ($\beta=.358$, $p<.05$) and 'flexibility ($\beta=-.273$, $p<.05$) being the only variables within this category to reach significance. In support of the stepwise analysis, this suggested that difficulties in overcoming drowsiness and rigidity in sleeping times were associated with greater problems. Work related variables also significantly predicted a substantial proportion of the variance ($R^2=.195$, $F=5.652$, $p<.01$). Inspection of the β-weights within this category showed 'control over job pacing' to be the most important variable and the only one to add significantly to the model ($\beta=-.393$, $p<.001$). Here, less control was associated with more problems.

Hierarchical analysis showed that, after the entry of demographic variables in step 1, circadian/personality variables in step 2 significantly improved the predictive power of the model (R^2 change=.254, F change=2.886, $p<.05$). At this stage, only 'flexibility' reached significance ($\beta=-.291$, $p<.05$). This was not improved with the entry of work related variables in step 3 (R^2 change=.083, F change=2.386, $p>.05$). In this final model only 1 variable had a significant β-weight: the circadian modifier of 'flexibility' ($\beta=-.320$, $p<.05$), although the work variable of 'control over job pacing' approached an acceptable level ($\beta=-.215$, $p=.076$).

When entered on their own, demographic variables predicted 15.7% of the total variance in psychological health and sleep at T2 ($F=1.810$, $p>.05$). No variables reached significance. Circadian/personality modifiers contributed the greatest proportion overall, at 21% ($F=2.732$, $p<.05$), although within this category, no single variable yielded a significant β-weight. Work related variables emerged as the weakest overall predictor of psychological health and sleep, accounting for just 8.2% of the total variance ($F=2.054$, $p>.05$), although within this category, 'control over job pacing' was moderately significant ($\beta=-.256$, $p<.05$).

Hierarchical analysis of T2 responses found a non-significant rise in predictive power with the introduction of circadian/personality variables in step 2 (R^2 change=.157, F change=1.810, $p>.05$). The addition of work related variables in step 3 also had the same effect (R^2 change=.011, F change=0.268, $p>.05$). No modifier yielded a significant β-weight during any of the 3 stages of the model building process.

Summary

As with social and domestic interference, circadian/personality variables contributed the highest proportion of the variance in psychological health and sleep when tested at both time points, in isolation and in combination with the other categories. When tested in isolation, circadian/personality variables predicted over 20% of the total variance. Although this was decreased when the effects of demographic variables had been partialled out, they remained the most powerful category of predictors (in T1 but not T2). However, taken together the former two categories had a substantial mediating impact upon work related variables, decreasing their predictive power by 1.2% and 7.1% at T1 and T2 respectively.

Physical Health

When entered in a stepwise model, only 1 modifier emerged as a predictor of physical health at T1. Here 'flexibility' accounted for 8.9% of the variance ($F=6.137$, $p<.05$), where a β-weight of -.298 ($p<.05$) indicated that having rigid sleeping habits was associated with more problems. At T2 'control over job pacing', 'contract type' and 'perceived sleep need' were extracted in a model that explained 49.4%. 'Control over job pacing' contributed the largest proportion, at 22.4% ($F=8.101$, $p<.01$), with 'contract type' contributing a further 19.1% (F change=8.796, $p<.01$) and 'perceived sleep need' the remaining 8.4% (F change=4.357, $p<.05$). Inspection of the β-values showed that physical health problems were higher amongst those who perceived themselves as having less control ($\beta=-.466$, $p<.01$), employed personnel ($\beta=.382$, $p<.05$) and long sleepers ($\beta=.295$, $p<.05$).

When entered as a single block, demographic variables accounted for 7.4% of the variance in physical health at T1 ($F=.0773$, $p>.05$), where only 'age' approached significance ($\beta=-.269$, $p=.071$). Circadian/personality variables contributed just under double this amount, accounting for 14% ($F=1.681$, $p>.05$), with 'flexibility' approaching significance ($\beta=-.242$, $p=.055$). Work related variables also failed to yield a significant solution ($R^2=.078$, $F=1.949$, $p>.05$).

In terms of hierarchical analysis, following the entry of demographic variables in the first step, circadian/personality variables in the second step explained a further 11.8% at T1 (F change=1.047, $p>.05$). Work related variables entered in the third step again failed to add significantly to the model, although it's unique contribution to the model was 4.4% (F change=.909, $p>.05$). Inspection of the β-values showed that no variable added significantly to the equation at any stage of the model building process.

At T2, demographic variables entered as a single block predicted 10.4% of the variance in physical health ($F=1.01$, $p>.05$), with 'contract type' yielding a significant β-weight ($\beta=.495$, $p<.05$). Circadian/personality modifiers together accounted for the highest proportion overall ($R^2=.274$, $F=1.345$, $p>.05$), although here no single variable contributed significantly to the equation. Work related variables added a similar amount, at 25.4% ($F=2.949$, $p>.05$), with 'control over job pacing' yielding a significant β-weight at -.483 ($p<.01$). As before, having more control over the pacing of the job was associated with fewer physical health problems.

Hierarchical regression of T2 responses found that, after demographic variables, circadian/personality modifiers in step 2 failed to add significantly to the predictive power of the model ($R^2=.18.5$, F change=0.713, $p>.05$). This was also true of work related variables added in step 3 ($R^2=.189$, F change=2.068, $p>.05$). Inspection of the β statistics showed 'contract type' ($\beta=.513$, $p<.05$) and 'control over job pacing' ($\beta=-.452$, $p<.05$) to be the only variables to achieve significance.

Summary

In summary, although circadian/personality modifiers accounted for the highest proportion of the total variance in physical health when tested in isolation, at both T1 and T2, when tested in a model building approach, their overall predictive power was mediated by demographic variables. Furthermore, as hypothesised, holding demographic and circadian/personality variables constant resulted in a decrease in the power of work related variables, suggesting that, taken together, the former two categories had a mediating impact upon modifiers included here.

Alertness and Safety

Stepwise analysis of T1 responses yielded 3 predictors, that between them, accounted for 31.4% of the total variance. 'Languidity' was the most important, accounting for 17.8% of the total ($F=13.612$, $p<.001$), where $\beta=.337$ ($p<.01$), indicated that difficulties overcoming drowsiness were associated with greater concerns about safety. The second predictor was 'extroversion', accounting for just 8.1% (F change=6.782, $p<.05$). Here, scoring highly on extroversion was associated with less perceived risk ($\beta=-.241$, $p<.05$). Finally, 'control over job pacing' accounted for a further 5.5% (F change=4.899, $p<.05$) with a negative β-weight indicating that greater control was associated with more confidence ($\beta=-.245$, $p<.05$).

At T2 'contract type' was the strongest predictor, accounting for 25.4% ($F=9.5511$, $p<.01$), where as before, employed personnel were more likely to experience problems than contract staff ($\beta=.440$, $p<.01$). 'Perceived sleep need' accounted for a further 11.6% (F change=4.963, $p<.05$), with a positive β-weight indicating that longer sleepers had less confidence in their safety ($\beta=.346$, $p<.05$), perhaps due to the perception that they failed to get sufficient rest.

At T1, demographic variables entered as a single block predicted the least variance overall with a contribution of 10.4% ($F=1.131$, $p>.05$), with no variable reaching significance. Circadian/personality variables predicted substantially more at 31.7% ($F=4.766$, $p<.001$). By far the strongest variable within this category was 'languidity', with a β-value of .499 ($p<.001$), although both 'extroversion' ($\beta=-.297$, $p<.05$) and 'morningness' ($\beta=.250$, $p<.05$) reached acceptable levels. Finally, work related variables predicted 15.9% of the variance ($F=4.338$, $p<.01$). In support of the stepwise analysis, 'control over job pacing' yielded a significant β-value ($\beta=-.382$, $p<.001$), indicating that less control was associated with more problems.

In the model building approach, after the entry of demographic variables in step 1, circadian/personality variables in step 2 significantly explained a further 27.2% of unique variance in risk at T1 (F change=3.117, $p<.01$), with 'languidity' ($\beta=.394$, $p<.05$) and 'extroversion' ($\beta=-.340$, $p<.05$) being the only modifiers within the category to add significantly to the model. Work related variables in step 3 accounted for a further 5.2% but failed to reach significance (F change=1.436, $p>.05$). Inspection of the β-weights in this final equation generally supported the stepwise analysis, showing 'languidity' ($\beta=.402$, $p<.05$) to be the only modifier to add significantly.

At T2, demographic variables were the most important predictors of risk, where, when entered as a single block, they accounted for a large 41.6% of the total variance ($F=2.446$, $p<.05$). Such a high percentage of explained variance may be a result of the small sample size in relation to the number of independent variables included in the analysis. 'Contract type' was the most powerful of these (β=.542, $p<.01$) being the only variable to enter the equation. Similarly, circadian/personality modifiers also predicted a high proportion of variance (R^2=.314, F=1.635, $p>.05$), although in this case, no single variable added significantly to the model. Work related variables when entered as a single block, accounted for the lowest overall contribution (R^2=.173, F=1.816, $p>.05$), and failed to reach significance, mirrored in the β-values of its component variables.

In hierarchical analysis, circadian/personality variables in step 2 failed to significantly improve the prediction of risk at T2 despite accounting for 25.5% of the total variance (F change=1.664, $p>.05$). In contrast to the stepwise model, 'age' emerged as the most important modifier (β=-.609, $p<.05$), followed by 'extroversion' (β=-.409, $p<.05$) and 'contract type' (β=.394, $p<.05$). Thus, increasing age, an introverted personality and being directly employed by the company were all associated with less confidence in safety. Work related variables entered in the final step predicted a further 3.5%, but failed to reach significance (F change=0.482, $p>.05$). In this final model only 'age' reached a significant level (β=-.605, $p<.05$).

Summary

In summary, the findings from the hierarchical analysis suggest that demographic variables had a moderate mediating impact upon the predictive power of circadian/personality variables. Whilst circadian/personality modifiers accounted for the highest proportion of variance at T1 at over 30%, this was reduced to 27.2% when demographic variables were held constant. The same was true at T2 where, when tested in isolation circadian/personality variables explained 31.4%, decreasing to 25.5% when tested in the model building approach. Together the two categories also had a strong mediating impact on work related variables, reducing their predictive power by over 10% at both T1 and T2. However, whilst circadian/personality variables were the strongest predictors at T1, at T2 demographic variables emerged as the stronger of all the categories.

Sleep Length

When entered into stepwise analysis, only two modifier variables emerged as predictors of sleep length before the first work day. Here, 'perceived sleep need' accounted for 10.6% (F=7.433, $p<.01$) of the variance with 'strength of early/late preferences' predicting a further 6.4%. (F change=4.814, $p<.05$). Inspection of the β-values indicated that longer sleepers (β=.300, $p<.05$) and those with weak preferences (β=-.255, $p<.05$) obtained more sleep.

When entered as a single block, demographic modifiers predicted 7.3% of the variance in sleep length before the first work day ($F=0.752$, $p>.05$), with no variable adding significantly to the equation. In contrast, circadian/personality variables significantly predicted 22.2% ($F=2.893$, $p<.01$) where only 'perceived sleep need' added to the model ($\beta=.361$, $p<.01$). Whilst not significant, both 'strength of early/late preferences' ($\beta=-.226$, $p=.052$) and 'morningness' ($\beta=-.237$, $p=.072$) approached an acceptable level. Finally, work related variables contributed the least, accounting for just 2.2% ($F=0.490$, $p>.05$). Hierarchical regression showed that, after the entry of demographic variables in step 1, neither circadian/personality (step 2) nor work related variables (step 3) significantly improved the prediction of sleep length In the final model no variables were found to have significant β-weights.

'Perceived sleep need' also emerged as the most important predictor for sleep length between successive work days, although this was true of responses at T1 only. Here, as expected, longer sleepers tended to sleep more than shorter sleepers ($R^2=.246$, $F=20.600$, $p<.001$; $\beta=.458$, $p<.001$). Also included in this model was 'morningness' which accounted for a further 5.6% of the variance (F change=4.981, $p<.05$). Here a tendency toward morningness was associated with less sleep ($\beta=-.240$, $p<.05$). No predictors emerged at T2.

At T1, when entered as a single block, demographic modifiers predicted just 2.4% of the total variance ($F=0.230$, $p>.05$), with work related variables accounting for a similarly low value of 2.7% ($F=0.604$, $p>.05$). In contrast, circadian/personality variables yielded a highly significant result, explaining 36.2% of the variance ($F=5.675$, $p<.001$). Inspection of the β-values of variables within this category indicated that only 'perceived sleep need' reached significance ($\beta=.501$, $p<.001$). At T2, none of the predictor sets resulted in a significant model, although, of the three categories entered, demographic variables accounted for the highest proportion of variance overall ($R^2=.287$, $F=1.325$, $p>.05$). No variable yielded significant β-values at any of the model building stages.

Hierarchical analysis fully supported these findings where, at T1, after the entry of demographic variables in step 1, circadian/personality variables entered in step 2 significantly improved the predictive power of the model (R^2 change=.363, F change=4.229, $p<.001$). Work related variables added in step 3 failed to have such an effect (R^2 change=.019, F change=0.491, $p>.05$). Here 'perceived sleep need' emerged as the only significant predictor at step 2 and 3. At T2, neither circadian/personality, nor work related variables increased the power of the model. No single variable achieved significance at any stage.

For the length of sleep obtained after the last work day, 7 predictors emerged, between them accounting for 78.5% of the variance. The most important of these was 'locality', where those living further away from the plant obtained more sleep (R^2=.124, F change=4.477, p<.05; β=.523, p<.001). 'Number of dependants' emerged as the second strongest predictor, accounting for 18% of the variance (F=5.720, p<.05), where having more children was associated with less sleep (β=-.495, p<.001). 'Control over job pacing' accounted for 9.4% of the variance (F change=4.528, p<.05), where β=.-.413 (p<.001) suggested that greater control was associated with less sleep. 'Extroversion' and 'shiftwork experience' accounted for similar proportions, 12.3% (F change=7.646, p<.05) for the former and 12.7% (F change=5.339, p<.05) for the latter. Inspection of the β-weights suggested that extroversion was the more important of the two, where β=.394 (p<.01) indicated that extroverts gained more sleep. For shiftwork experience, β=-.304 (p<.01) indicated that as experience increased, the amount of sleep decreased. 'Control over shifts' and 'marital status' accounted for the smallest proportions of variance overall, with more control being associated with more sleep (R^2 change=.074, F change=5.601, p<.05; β=.275, p<.05), and having a partner being associated with less sleep (R^2 change=.063, F change=5.808, p<.05; β=-.270, p<.05).

When entered individually, only demographic variables achieved significance (R^2=.669, F=6.352, p<.001). Inspection of the β-values showed 6 of the 7 variables ('contract type' being the only exception) within this category to yield significant β-weights, further underlining the importance of such modifiers. Of the remaining categories, 'extroversion' was the only other single modifier to approach, but not reach, significance (β=.373, p=0.76). When hierarchical analysis was performed, results showed that whilst circadian/personality variables failed to increase the predictive power of the model (R^2 change=.101, F change=0.817, p>.05), work related variables in step 3, resulted in a substantial improvement (R^2 change=.164, F change=8.340, p<.01), thus suggesting that demographic variables had a strong mediating effect upon circadian/personality modifiers but, when taken together, the two had no mediating effect upon work related variables. Within this final model, 9 of the total 17 variables entered had significant β-values.

Finally, for sleep length between successive rest days, 5 predictors emerged, 'languidity', 'number of dependants', 'control over shifts', 'strength of early/late preferences' and 'gender', that between them accounted for 64.1% of the variance. Here, languidity (β=.457, p<.01), fewer dependants (β=-.421, p<.01), greater perceived control (β=.357, p<.05), strong preferences (β=.315, p<.05) and being female (β=-.286, p<.05) were all associated with more sleep.

When entered individually in blocks, findings generally supported the stepwise analysis. Although none of the three categories of modifiers reached significance, inspection of the β-values showed both 'age' (β=-.518, $p<.05$) and 'number of dependants' (β=-.433, $p<.05$) to yield β-values within the acceptable level. This was further underlined when the modifiers were entered sequentially. After the entry of demographic variables in step 1, circadian/personality variables entered in step 2 failed to increase the predictive power of the model, as was the case with work related variables in step 3. The final model contained 4 variables ('number of dependants', 'control over shifts', 'marital status', and 'strength of early/late preferences', listed in order of importance).

Summary

Thus, taken together the findings suggested that for sleep lengths at T1 (i.e., length before the first work day and between successive work days), circadian/personality variables were the strongest predictors. For sleep lengths at T2 (i.e., between successive work days, after the last work day and between successive rest days), demographic variables accounted for the highest proportion of variance. However when tested in a hierarchical model, the strength of circadian/personality modifiers were decreased in all cases when the effects of demographic modifiers were held constant. When both were combined, they were found to have a mediating impact upon the strength of work related variables, although this was true at T1 only.

8.4. Discussion

Early on in the analysis the possible mediating influence of contract type in the experience of shiftwork at the site was identified (Warr, 1983). Exhaustion was one of the major complaints throughout the 21 interviews conducted. For those directly employed by the company, this was attributed to the fact that workers had adjusted to their normal pattern of rotating shifts involving blocks of between 2 and 14 rest days between shifts, whereas the turnaround phase involved working long runs of successive shifts with few days off (this may explain why those employed directly by the company perceived more risks to their safety in regression analysis, although this was true at T2 only). In contrast, for contracted personnel, feelings of exhaustion were attributed to difficulties in finding and travelling to accommodation. Social and domestic impairment was also identified by both groups, though again the reasons behind this differed according to the type of contract held. Despite the insights gained from the interviews, as in previous chapters, monetary reward was the most important motivation for working shifts amongst all respondents, regardless of the problems incurred.

With relation to the interviews conducted in Chapter 5, few similarities were noted. This was not surprising given the *ad hoc* manner in which they were conducted in this instance. Furthermore, because a cross-section of those working at the site were not included, the trends identified were limited and could not be generalised to the rest of the sample. It could be argued for example, that those who wished to talk about their problems shared common characteristics underlying this motivation and, therefore, were not representative of the population as a whole.

An original intention of the study had been to compare the level of tolerance between those who had, and had not, taken rest days in accordance with the Working Time Directive. Unfortunately, due to a poor response rate at T2, where these details were asked, an exploration of the percentage of personnel taking rest days, how restful these days were perceived to be, and the ratio of those who, given the choice, would prefer to work straight through the turnaround phase rather than taking 'enforced rest periods', could not be assessed. Yet it was the overwhelming topic of the interviews, where the majority of personnel stated that, since they were not able to use their rest days as desired, they would prefer to work straight through the period. Contractors commented that time off was spent 'wasting' wages and having to find things to do, because 'home' for them was too far away. In contrast, employed personnel argued that having to take rest days hampered their adjustment to the turnaround shift system.

Despite having a smaller cohort compared to previous studies, it nevertheless proved possible to replicate several of the outcome mega-factors identified in previous chapters. Furthermore, since the present study included both psychological health and risk measures it provided an opportunity to explore the role of on-shift alertness in both. Results showed the measure to load on both the psychological health and sleep factor (as found in Chapter 6) and to the perceived risk factor (as found in Chapter 7). On the former, alertness had the lowest loading of all component items and reduced the overall reliability of the scale (although this was still acceptable at .86), whilst in the latter it loaded more strongly, with no single item reducing the total scale alpha (although this was low at .54). Whilst such a result suggested that on-shift alertness was more strongly linked to risk items, further analysis using an exploratory approach found it to be related to only the 'confidence in driving home following work' item of the factor. However, given that the sample used here was small and that the amount of missing data on the alertness scale was high, any conclusions should be made with great caution. Bearing this in mind, the present study nevertheless supported the findings from Chapter 7 in highlighting a link between alertness and perceived risk, a link that, as discussed previously, is not recognised by models of shiftwork tolerance, yet was uncovered in the more in-depth interviews reported in Chapter 5 *and* is supported by a large body of literature on the association between fatigue and industrial accidents (e.g. Carter *et al.*, 1982; Monk *et al.*, 1996; Folkard and Hill, 2000, 2001).

In terms of the relationships between outcome variables, all but the perceived advantages item correlated at T1 and T2. Thus, despite factor analysis not being performed separately for T2 due to insufficient data, the structures derived at T1 held over time. In relation to previous chapters, similar trends were also found. A strong correlation existed between attitudes towards shiftwork and social and domestic interference (as with Chapters 6 and 7), although there were differences between time points. The perception of 'whether the advantages of shiftwork outweighed the disadvantages' at T1 failed to correlate with T1 social and domestic interference, yet at T2 this item was associated with impairment at both the initial and follow-up stages. Furthermore, whilst a 'preference for daywork over shifts' was (significantly) positively correlated with social and domestic impairment at T1, at T2 a (non-significant) negative relationship was found. This suggests that there may be a change in the relationship over time, although again the poor response rate at T2 makes such conclusions weak.

In terms of psychological health and sleep, relationships with both social and domestic interference and physical health supported those in Chapter 6, and were consistent over time. The only relationship not evident here was that between psychological health and sleep and either of the two attitudes measures. However, this was indicative of all relationships involving attitudes measures, which showed the fewest correlations overall. In previous chapters correlations had been found between attitudes and physical health (Chapter 6 and 7) and alertness and safety (Chapter 7) whereas in this instance no associations were found at either time point. In contrast, correlations between social and domestic interference and alertness and safety were supported, although the relationship was stronger at T2. In the same vein, social and domestic interference and physical health achieved significance at T2 only. As discussed later in this section, changes in outcome variables between T1 and T2 may provide possible explanations for the pattern of findings. Overall the trends gave greater support to those obtained in Chapter 6, although this is perhaps not surprising given that the survey used in the present study was of a similar structure and depth.

Analysis of outcome variables over the 5 week period revealed a worsening of all but physical health (attributed to the gastrointestinal subscale), a preference for daywork, and alertness and safety at follow-up, providing some evidence that workers were being adversely affected as their experience of the shift progressed. Despite the paucity of significant differences, the most substantial change was found for sleep quality during rest days, supporting evidence from the literature that shiftwork can affect a worker's lifestyle in and of work time. It is unlikely that this was attributable to the time spent asleep since no significant difference between sleep length during rest days at T1 and T2 were found. Indeed, at T2 sleep length during rest days was found to decrease by an average of just 12 minutes compared to T1.

The introduction of modifiers in regression analyses also resulted in mixed findings. Although predictive relationships were found in almost all of the outcome variables employed, there was little support for these relationships over time, supporting Bohle *et al.* (1989). Indeed, only one outcome variable showed such consistency, where, for psychological health and sleep, 'languidity/vigorousness' was extracted at both T1 and T2.

In support of earlier analysis, strongly correlated outcomes also showed the most similarity in terms of the predictors extracted. For example, psychological health & sleep and alertness & safety were strongly positively correlated at both T1 (.577, $p<.001$) and T2 (.658, $p<.001$). Equations derived at T1 extracted 'languidity' and 'control over job pacing' for both factors, although different predictors emerged at T2. Similarly, strong correlations existed between the two health outcomes at both time points (psychological: .532, $p<.001$, and physical: .548, $p<.001$, respectively), where, at T1, the circadian modifier of 'flexibility' emerged as a common predictor. Again there was no consistency over time. Stepwise analysis also further underlined the lack of an association between attitude measures, with different sets of predictor variables emerging for each item. 'Contract type', found to be an important factor in the interviews, emerged as the most important predictor of perceived advantages at T1, whilst for T1 preference for daywork, 'perceived sleep need' was the only modifier extracted. At T2 different sets of predictors were found for both items, although 'flexibility' was extracted in each case. Thus, as with other variables, relationships appeared to be attenuated with time, with no clear pattern emerging.

Comparisons with previous studies showed a number of similarities. In terms of shiftwork attitudes, 'locality', that emerged here for a preference for daywork (T2), also appeared in Chapter 6, although there was a considerable difference in the R^2 values on each occasion. In Chapter 7 the related variable of 'commuting time' was found to be an important predictor amongst those working permanent shifts. The circadian theme derived for the health outcomes seen here was also typical across studies, with 'languidity' entering the equation for psychological health and sleep both here and in Chapter 6. Although circadian type played an important role in the prediction of physical health throughout the research this far, a tendency toward 'flexibility' emerged in this and the previous study, whereas in Chapter 6 the related modifier of 'languidity' was extracted. Similarly, the perception of control over aspects of work was also evident across studies, although the actual modifier in each case varied ('control over job pacing' in the present study, 'control over shifts' in Chapter 7, and 'job demand' in Chapter 6). 'Languidity' also emerged as a strong predictor for alertness and safety, where, once again 'control over job pacing' entered the equation for both the present and previous study. In terms of sleep length, 'perceived sleep need' was extracted in Chapter 6 and here, whilst for the amount of sleep gained between successive shifts, 'number of children' was a common predictor.

In some cases, whether the relationships had been influenced by experience of the shift could not be assessed, as no equations were extracted at T2 (e.g. social and domestic disruption and sleep between successive work days). Despite this, further analysis by way of hierarchical regression provided key information revealing consistency between both outcomes and time points on the former of these outcomes.

As can be seen in Table 8.10, when entered in individual blocks, circadian/personality variables proved to be the most important group of predictors at both T1 and T2, whereas work related modifiers explained the least amount of variance overall. Indeed, this was the case for most outcomes, where patterns of prediction are clearly evident.

Table 8.10. Summary of trends in hierarchical regression (individual blocks) †‡ amongst oil refinery workers

	T1	T2
Advantages outweigh disadvantages	D – W – C	C – D – W
Preference for daywork	C – D – W	D – C – W
Social and domestic interference	C – D – W	C – D – W
Psychological health and sleep	C – W – D	C – D – W
Physical health	C – W – D	C – D – W
Alertness and safety	C – W – D	D – C – W
Sleep length before 1st shift	C – D – W	-
Sleep length between successive shifts	C – W – D	D – C – W
Sleep length after last shift	-	D – C – W
Sleep length between successive rest days	-	D – C – W

D=Demographic; C=Circadian/Personality; W=Work
† predictors presented in order of importance in all cases
‡ reflects higher impairments in all outcome measures

As with earlier findings, similar patterns were generally found amongst outcomes that correlated highly with one another. At T1 two major trends can be seen, both of which show circadian/personality modifiers to be the strongest category overall. However in the first of these trends, seen for the two health measures, alertness and safety and sleep length between successive shifts, demographic variables were the weakest, whilst in contrast, for a preference for daywork, social and domestic interference and sleep length before the first shift, work related variables explained the least amount of variance overall. An exception was seen for the perceived advantages of shiftwork. Here demographic modifiers explained the greatest proportion of variance, with circadian/personality the weakest of the three categories.

Two patterns of predictors also predominated at T2. Four of the nine outcome measures had predictors in the order Circadian/personality – Demographic – Work (as at T1), whilst the remaining five had predictors in the order Demographic – Circadian/personality – Work. Although few modifiers emerged from stepwise analysis in the prediction of social and domestic interference, when entered in individual blocks, this was the only outcome variable to show a consistent trend across time.

As before the pattern of results revealed here only partially supported those of previous chapters, with few complete patterns concurring across studies. Support for social and domestic disruption was most consistent, with circadian characteristics being the strongest category in all 3 studies. The C-D-W pattern of predictors derived here was also evident in Chapter 7, although this was only true amongst those groups working nightwork as part of their shift system. The strength of circadian modifiers was further underlined for psychological health and sleep, with the C-W-D pattern found at T1, matching that found in Chapter 6. In terms of attitudes towards shiftwork, the D-W-C arrangement seen for T1 perception of advantages corresponded with results gained from maintenance engineers, although this was true of the rotating without nights group only. Furthermore, the C-D-W pattern seen for attitude items here was only evident amongst those working rotating shifts with nights in Chapter 7. Varying results were evident for physical health across studies, although the pattern found for T2 concurred with that found amongst the rotating with nights and permanent night's groups of the previous chapter, whilst the T1 pattern matched that in Chapter 6. In terms of alertness and safety, results were split. For whilst T1 findings matched those for perceived risk during afternoon and nights in Chapter 7, at T2 the pattern supported those relating to periods of morning work only. Finally, for sleep length, few similarities were noted, although the D-C-W pattern so prominent in the present study was also found in previous chapters, especially for the length of sleep between successive rest days.

Interestingly, despite several similarities between studies, when related to the previous chapter most occurred in line with either those working nights as part of their shift system or rotating shiftworkers. There was no concurrence with those working permanent days, the shift worked here. Because both employed and contracted personnel had worked rotating shifts previous to the start of the turnaround phase this may suggest that their tolerance to the work pattern used during turnaround periods at the site was mediated by carry over effects, and that the 5 week period had not been sufficient for these to have dissipated. This would be especially true at T1 where workers had only 10 days experience of the new shift system, although when tested at T2 experience was still relatively low at between 28-35 days. In Chapter 6 experience of the present shift ranged form 1-3 years and in the previous study ranged from 2 to 7 years.

Entering the modifiers sequentially, in most cases, appeared to endorse the hypothesised direction of effects. At T1 the addition of circadian modifiers increased the predictive power of the equation for physical health, alertness and safety and sleep length between successive shifts, whereas at T2 increases were seen for the attitude towards shiftwork items only. Here circadian modifiers resulted in an increase for both, whilst work related variables entered in the final step contributed further for the preference for daywork item. Overall, the results offered little support to those derived from previous chapters.

Whether these results truly supported the hypothesised direction of effects is difficult to conclude with any degree of confidence given the small sample size used in the analysis. As aforementioned some authors advocate that, when using regression analysis, 5 participants should be included for each independent variable, although some believe the figure should be closer to 40. The combination of a poor response rate and missing data on key scales used to construct factors meant that the amount of data used in the regression analysis was low. Indeed, the degrees of freedom values throughout the regression summary tables reveal that at most the sample reached 64, with the lowest being just 20. According to the above caveat both are well below the threshold for reliable results, given that 17 modifier variables were included in the analysis. Another possible explanation may lie in the time span of the study. At the beginning of the chapter we questioned whether 5 weeks would be sufficient time for changes in the outcome variables, and relationships between outcomes and modifiers, to manifest themselves and therefore be detectable. Further research using a longer time span is needed to assess this.

Although the present study allowed the opportunity of exploring whether the relationships uncovered in previous chapters existed in a longitudinal design, there were a number of weaknesses affecting both the interpretability and reliability of findings. The most pertinent was the poor response rate. In contrast to the willingness of interviewees to express their problems, a similar motivation was not seen for the survey. At T1 those who completed the survey represented only 4.9% of the population at the site, whilst at T2 this figure was even lower at just 1.95%. Not only does this limit the generalisability of findings to all those working at the site, but as mentioned above, a small sample size can be problematic when conducting powerful statistical analysis such as regression, since it can lead to inflated values of the proportion of variance explained by predictor variables. Indeed, high percentages were obtained during stepwise analysis with 78.5% explained for the length of sleep between successive work days, whilst between successive rest days this was slightly lower at 64%. Furthermore, the highest overall percentages were evident at T2 where the response rate was lowest. Conclusions based on these results should therefore bear this in mind.

The main aim of this study was to explore whether the relationships uncovered in previous studies were supported here and to extend this work by investigating whether they existed over time. Whilst a number of similarities were noted, in general, consistency across both studies and time was limited. The present study nevertheless verified a link between alertness and measures of perceived risk, supported the clustering of correlations amongst certain outcome variables, and supported the strength of circadian modifiers in the prediction of outcomes. Whether this was due to the type of industry examined, the number of responses gained, or whether 5 weeks was insufficient time for changes to manifest themselves could not be concluded. However since these questions are fundamental to our understanding of the dynamics of shiftwork tolerance, further research is needed to address these questions in greater depth. The following study aimed to address each of these aspects.

9

THE EFFECT OF LONG-TERM EXPOSURE ON SHIFTWORK TOLERANCE

9.1. Introduction

This chapter is the second of two studies exploring relationships between outcomes and modifiers of shiftwork tolerance in a longitudinal paradigm. Here the effect of a long-term shift system are assessed. In contrast to short-term longitudinal designs, long-term studies of this type have been reported more frequently in the literature (e.g., Meers *et al.*, 1978; Knutsson *et al.*, 1986; Coburn, 1996), with follow-ups ranging from 6 months to 15 years. In general these have shown that for some outcomes, such as cardiovascular disease, there exists an exponential increase in risk with shiftwork exposure (even where contributory factors such as age and smoking have been controlled for). However some argue that as shiftwork exposure increases, adaptation takes place, having a positive effect on the shiftworker's ability to cope with the problems they experience (incorporated in the model proposed by Haider *et al*, 1988). Despite this, very few authors acknowledge the role played by individual differences or the relative impact of certain modifier variables in these relationships. Is it the case, for example, that the two arguments are mutually exclusive or that they reflect the fact that only certain outcomes are affected by long-term exposure, whilst others are more sensitive to changes in the short-term?

The previous chapter argued that the 5 week period over which the study was conducted was insufficient time for the adverse effects of the shift system to be established, or for the carry over effects of the previous shift system to have dissipated. In this instance shiftworkers completed a baseline survey (T1) on a range of measures during February and March 2000. Follow-up surveys (T2) were completed 12 months later.

9.2. Method

9.2.1. Questionnaire Administration

Data collection took place within an automobile manufacturing company in South Wales, UK. Participants were informed of the research through three methods: (1) by their line supervisors, (2) through advertisements (posters and leaflets) placed around the site, and (3) were approached during break times by the researcher, both in the on-site canteen, and rest areas situated around the plant. In the first instance questionnaires were completed during pre-arranged testing sessions in work time within a room situated on the shop floor. Although no time restrictions were enforced most surveys were completed within 30-45 minutes. However, due to manufacturing demands, such a provision became increasingly difficult to maintain and all remaining volunteers completed their questionnaires in their own time. For the follow-up survey all questionnaires were sent to participants' home addresses and returned via pre-paid envelopes. Reminder letters were sent out 2 weeks and 4 weeks after distribution of the surveys at both T1 and T2. Where no responses were received after this time no further reminders were sent. All of those who completed both questionnaires were entered into a £200 cash prize draw, with two runners up receiving £50 each.

9.2.2. Participants

At T1 completed questionnaires were returned by 168 workers of the initial 530 who received one, giving a response rate of 31.7% overall. Of these, 3% (n=5) worked 8h permanent days, 1.8% (n=3) worked discontinuous 8h rotating shifts without nights, 7.7% (n=13) worked 12h continuous rotating shifts with nights, and 87.5% (n=147) worked 8h discontinuous rotating shifts with nights. At T2, 54 of the original cohort completed a questionnaire, giving a response rate of 32.3%. After excluding those who had changed shift patterns, retired or left the plant for other reasons since T1, this left 45 completed surveys from those working 8h discontinuous rotating shifts with nights. Because of the poor response overall from the aforementioned shift patterns, only those working 8h discontinuous rotating shifts with nights (5M2R5A2R5N2R) were used in further analysis.

It had originally been hoped that the data gained here would allow a comparison of 8h versus 12h shiftworkers, but given that only 13 completed surveys were returned from those in the latter group, such analysis was not appropriate. Another possibility was to include 'shift type' as a dummy variable (as in Chapter 6), but again this suffered its own complications. Despite the fact that it emerged as a predictor for the attitude measure of a 'preference for daywork over shifts', where analysis of the ß statistics showed those working 12h shifts to have a more favourable attitude toward their work pattern than those in the 8h group, its overall failure to enter the equation for any other outcome measure is difficult to interpret. For example, is it the case that there were insufficient cases in the 12h sample (13 twelve hour versus 147 eight hour) or that it simply was not a strong predictor? Given the lack of evidence to support either claim, further use of the 'shift type' variable was abandoned, and all subsequent analysis used the 8h discontinuous rotating shifts with nights group only.

9.2.2.1. Rotating with Nights

Demographical details are shown in Tables 9.1a and 9.1b. At T1, as in the previous studies the cohort were predominantly male, with 145 males and 2 females. Age ranged from 22 to 60 years, with a mean of 42.64 (SD 9.86). As expected this was reflected in a large variation in both work, and shiftwork, experience. Length of work experience ranged from as little as 1 month through to 46 years ($\bar{x}$ 25.59 yrs; SD 11.41 yrs) whilst shiftwork experience ranged from 1 month to 40 years ($\bar{x}$ 18.78 yrs; SD 10.63 yrs). Experience of the present shift system also showed a wide range from 2 weeks to 37 years ($\bar{x}$ 10.76 yrs; SD 10.26 yrs).

Of those sampled, 88.7% were married or living with a partner, 5.6% were single, and 5.6% separated/divorced or widowed. 63 had no children, whilst the remaining 84 had at least one child ($\bar{x}$ 1.11; SD 1.16, range 1-5). In terms of commuting time, the average length of getting to work was 44.06 minutes (SD 16.67; range 20mins-2h). Finally, whilst the number of hours that participants were contracted to work was around 37 ($\bar{x}$ 37.60; SD 3.85; range 8-49), the number actually worked was over 10h more at $\bar{x}$ 47.92 (SD 7.45, range 15-71).

Table 9.1a. Demographical details (mean, SD) of the sample

	Rotating with nights		
	$\bar{x}$	(SD)	Range
Age (yrs)	42.64	(9.86)	22-60
Work experience (yrs)	25.59	(11.41)	1 mth-46 yrs
Shiftwork experience (yrs)	18.78	(10.63)	1 mth-40 yrs
Present shift experience (yrs)	10.76	(10.26)	2 wks-37 yrs
Contracted hours/week	37.60	(3.85)	8-49
Actual hours/week	47.92	(7.45)	15-71
Commuting time (mins)	44.06	(16.67)	20 mins-2 hrs
Number of children	1.11	(1.16)	0-5

Table 9.1b. Demographical details (frequencies) of the sample

	Rotating with nights	
	Frequency	%
Gender:		
Male	145	98.6
Female	2	1.4
Marital Status:		
Married/living with partner	126	88.7
Single	8	5.6
Separated/divorced	8	5.6
Dependants:		
0	63	43.2
1	28	19.2
2	34	23.3
3	19	13.0
4	1	0.7
5	1	0.7

9.2.3. *Materials*

As before, the structure of the survey used in this instance (see Appendix 9) was based around the theoretical model of moderators and outcomes of shiftwork, from Folkard *et al.* (1995), and thus many of the measures used were based on, or derived from, those contained within the SSI (Barton *et al.*, 1995) and the SOS (Folkard *et al.*, 1997). Initially questionnaires were to be completed during company time, and so every effort was made to keep it as short as possible, with the final version being 13 pages in length and divided into 7 sections. The following section summarises the measures employed. Since all are measures that have been used in previous studies within the thesis, they are simply listed here.

Where appropriate, the psychometric properties of the scales are also summarised for comparison with previous research (see Table 9.2, Appendix 5). All factor analysis used Principal Components Analysis with Varimax rotation. However, as before, due to the small number of participants in the present sample, further analysis was based on the original scoring methods, *on all scales*, to allow comparison with previous work.

9.2.3.1. Modifier Variables

Demographic

Variables included in this category were age, gender, marital status, number of dependants, hours contracted to work each week, hours actually worked each week, years of work experience, years of shiftwork experience, present shift experience, and commuting time. Nominal variables with more than one category were recoded into dichotomous measures for analysis.

Circadian

- Circadian Type Inventory (18-item measure)
- Time Awareness Questionnaire (38-item measure, but scored according to reduced 29 item version)
- Perceived Sleep Need

Personality

- Eysenck Personality Inventory (12-item measure)
- Shiftwork Locus of Control (8-item measure)
- Coping Strategies Questionnaire (abridged version)

Work-Related

- Control over job pacing (single item measure)
- General Job Satisfaction (5-item measure)
- Perceived workload

The two single items relating to perceived control over the shifts worked and the start and finish times of the shifts worked, as used in previous studies, should have been included here but, unfortunately, were omitted during the questionnaire preparation. The consequences of this are considered within the Results section of the chapter.

9.2.3.2. Outcome Variables

Sleep, Alertness and Fatigue

- Sleep onset and wake times
- Sleep disturbance (8-item measure)
- Subjective alertness
- Mental fatigue (9-item measure)
- Physical fatigue (3-item measure)

Physical Health

- Physical Health Questionnaire (21-item measure)

Psychological Health

- General Health Questionnaire (12-item measure)
- Cognitive-Somatic Anxiety Questionnaire (14-item measure)

Social and Domestic Interference

- Social and Domestic Survey (3 item measure)

A measure of social support based on the Social Support Questionnaire from Sarason, Sarason, Shearin and Pierce (1987) was also included. However, due to substantial amounts of missing data on this scale, it was excluded from the analysis.

Attitudes toward Shiftwork

- Do the advantages of shiftwork outweigh the disadvantages? (single item)
- All things being equal, would you prefer daywork to shiftwork? (single item)
- 3 main advantages and 3 main disadvantages of present shift system (text responses)

9.2.3.3. The Follow-up Survey

The follow-up survey can be found in Appendix 9. As before, circadian and personality measures were not taken at T2 (since the test-retest reliability of the scales have been widely reported), but the EPI-12 was included for the neuroticism scale (used as an outcome measure throughout the research). Also, since the psychometric properties of the TAQ were being assessed throughout the research (reported in Chapter 6), it too was repeated in the follow-up survey. In all subsequent analysis individual difference measures taken at T1 were used.

Despite the positive findings with regard to the link between on-shift alertness and perceived risk to safety, the single items asking the 'likelihood of making a minor mistake at work' and 'confidence in driving home following work' were not included here. Due to the longitudinal design of the current study, the first phase had been completed and T2 data collection was underway before the studies reported in Chapters 7 and 8 had been conducted, where the concept of perceived risk was introduced.

9.3. Results

9.3.1. Statistical Analysis

In the first instance both outcome and modifier variables were subjected to correlational and/or factor analysis in an attempt to examine relationships, and, where possible, to decrease their total number. The following sections discuss the rationale behind doing so and the findings that resulted. Paired samples t-tests between measures at T1 and T2 were then performed to examine whether they had been moderated by time on shift. Multivariate analysis in the form of regressions were conducted to investigate the predictive power of modifiers for each outcome with the influence of covariates both uncontrolled and controlled, following the regime of previous chapters.

9.3.1.1. Reduction of Outcome Variables

Due to the small cohort size involved in the present study confirmatory factor analysis using the factor structures derived from Chapters 6, 7 and 8 were employed given that they were based on larger sample sizes. As before, where scales had been derived from individual items, the scale, rather than its component items, was used. Where factors were constructed, the standardised (z transformation) scores from the component items were used in creating the dimensions. Due to the reduced sample size at T2, factor analysis was not performed separately.

In the absence of perceived risk variables, an attempt to replicate the structure of the psychological health and sleep factor from Chapters 6 and 8 was made. Forcing quality of sleep during work and rest days, cognitive and physical fatigue, psychological health, cognitive and somatic anxiety, neuroticism, disengagement and on-shift alertness into a one factor solution, all resulted in a single factor, which accounted for 36.97% of the variance and had an eigenvalue of 4.808. Loadings ranged from +.253 through to +.757. Reliability analysis showed an acceptable alpha coefficient of .72, where the exclusion of only disengagement (α.7228) and on-shift alertness (α.8243) reduced the overall scale reliability. Thus the factor structure was retained and named "Psychological Health and Sleep".

When forced into a single factor solution, the four physical health subscales accounted for 52.26% of the total variance (eigenvalue 2.090), with all but the minor infections component loading highly. This was supported in reliability analysis where the total scale alpha of .67 was increased with the exclusion of 'minor infections', resulting in α .73. Despite this, the factor structure was retained and named "Physical Health", to allow comparisons with previous chapters.

Forcing the three single items measuring the extent to which shiftwork interfered with leisure, domestic and non-domestic life into a one factor solution resulted in a dimension that accounted for 57.32% of the variance (eigenvalue 1.720) with loadings ranging from .592 to .854. Cronbach alpha analysis showed an acceptable level of reliability of .61, although this was increased to .70 with the exclusion of the item regarding non-domestic life. Despite this, the structure was retained and named "Social and Domestic Interference". To allow comparison with previous studies, items relating to attitudes towards shiftwork and sleep durations were treated as separate variables in further analysis.

The strength of interactions between outcome variables was further explored by correlating the factors against one another. The results are summarised in Table 9.3 (overpage). As with the previous chapter, the majority of variables correlated consistently across time (the only exception being sleep length between successive rest days and between a quick return). Thus, as before, despite factor analysis not being performed separately for T2 responses the structures derived on the basis of T1 results held over time.

Two clusters of correlations are clearly evident from Table 9.3, with little cross-over between the two. The first occurs between outcome factors, with the second occurring amongst sleep lengths between different shift types and rest days. Indeed only T2 preference for days and social and domestic disruption showed relationships with sleep length, although even here associations were scarce.

In terms of the outcome factors, attitude items showed wide-ranging relationships, although trends differed across time. Despite the two attitude measures correlating highly with one another, in terms of relationships with other outcomes, disparate trends were found. T1 perceived advantages correlated with all but T2 social and domestic disruption, whilst at T2 only 3 associations were found (T2 social and domestic disruption, T1 and T2 physical health). Moreover, at T1 perceived advantages were most strongly linked to psychological health and sleep, whilst at T2 the strongest correlations were seen for physical health. In contrast, on the

Table 9.3. Correlations between outcome variables amongst automobile plant workers

		Perceived advantages		Preference for days		Social		Psychological health		Physical health		Sleep length between successive shifts							
												Morning		Afternoon		Night		Rest days	
		T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
Perceived adv..	T1	-																			
	T2	**.333***	-																
Pref. for days	T1	**-.403*****	-.261	-															
	T2	**-.562*****	-.264	**.560*****	-														
Social	T1	**-.422*****	-.181	**.342*****	.116	-													
	T2	**-.188**	**-.412****	**.266**	**.336***	**.313***	-												
Psych. health	T1	**-.260****	-.191	**.329*****	**.512*****	**.416*****	.182	-											
	T2	**-.489****	-.287	.318	**.587*****	.059	.266	**.770*****	-										
Physical health	T1	**-.250****	**-.408***	**.217****	**.575*****	**.400*****	.290	**.529*****	**.623*****	-									
	T2	**-.325***	**-.423****	**.319***	**.604*****	.214	**.461****	**.461****	**.636*****	**.865*****	-								
Sleep length																			
Morning	T1	-.083	-.181	.075	**.377***	.082	.028	.154	.299	.087	.031	-							
	T2	-.173	-.014	.211	**.353***	.093	-.004	.299	.059	.195	-.010	**.580*****	-						
Afternoon	T1	-.014	-.099	.017	.288	-.132	-.088	-.045	.109	.048	.064	**.199***	**.627*****	-					
	T2	-.096	-.260	.132	.313	.037	.085	.183	.010	.031	.170	.244	.383	**.791*****	-				
Night	T1	.008	-.254	-.055	.171	-.130	.189	-.041	.211	.092	.239	.102	.172	**.299*****	.358	-			
	T2	-.268	-.248	.112	.190	.021	.247	-.032	-.028	.049	.084	.345	**.355***	.148	.243	**.687*****	-		
Quick return	T1	.005	-.053	.092	-.006	-.120	.035	-.098	-.126	-.091	.128	.182	.271	**.255****	.162	-.023	.218	-	
	T2	-.279	.185	-.015	.207	.296	-.278	.050	-.148	.091	.041	.170	.308	**.548***	**.500***	**.708*****	**.465***	.445	-
Rest days	T1	-.069	.014	.028	.266	.005	.187	-.039	.064	.145	.289	.167	.304	**.391*****	.376	**.295*****	.120	-.082	.156
	T2	-.048	-.138	.162	**.372***	-.083	**.410***	.283	.106	.048	.237	.327	.085	.243	**.550****	.190	**.450***	.300	.231

*** p<.001 ** p<.01; * p<.05

preference for daywork item, T2 responses showed the highest number of relationships, correlating positively with the two health outcomes (T1 and T2), sleep length between successive morning shifts (T1 and T2) and rest days (T2), and social and domestic disruption (T2).

Although T1 preference for daywork showed fewer associations overall, they nevertheless occurred between the same factors. In both cases a less positive attitude was associated with greater psychological and physical health problems, greater disruption to social and domestic life and, where correlated, with more sleep. Associations between a preference for daywork and sleep lengths supported the findings of the previous chapter.

Social and domestic disruption showed the fewest relationships of all the factors, being associated with both health measures at T1 but only physical health at T2. Despite this, it was the only other measure to be associated with sleep length. The pattern of trends showed a strong correlation between social and domestic disruption and sleep between successive rest days. At T2, more disruption was indicative of more sleep during successive rest days. This was reciprocated in the preference for daywork item (although this occurred at T2 only). Additionally the links between social and domestic life and attitudes towards shiftwork as found in Chapters 6, 7, and 8, were corroborated here. As with the previous chapter, the strongest correlations overall were found amongst the two health outcome measures (where coefficients ranged from +.529 to +.636).

Despite specific patterns between outcomes occurring, a more general time-specific pattern was also found. Where significant relationships existed between variables at both T1 and T2, the T2 relationship was always stronger. For example, at T1 the correlation between perceived advantages and physical health was -.250 ($p<.01$) whilst at T2 it reached -.423 ($p<.01$). At T1 the correlation between psychological health and sleep and physical health was .529 ($p<.001$) whereas at T2 this increased to .636 ($p<.001$). One exception to this rule was the relationship between the perceived advantages of shiftwork and social and domestic interference, although the difference was only slight (T1=.422, $p<.001$; T2=.412, $p<.001$).

9.3.1.2. Reduction of Modifier Variables

As with previous chapters, due to the nature of regression analysis, the ratio of modifiers to both the number of outcome variables, and participants, posed a problem. Therefore, as before, in an attempt to reduce their total number, relationships between modifiers were examined through Pearson's correlations. Table 9.4 shows the remaining variables used in the analysis.

Strong relationships existed between 'age' and (1)'work experience' ($r_{(139)}$=.888, p<.001), (2) 'shiftwork experience' ($r_{(140)}$=.849, p<.001), and (3) 'length of present shift experience' ($r_{(140)}$=.531, p<.001). Furthermore, significant relationships were also found between all combinations of work, shiftwork and present shift experience. To allow comparison with previous chapters only 'age' and 'shiftwork experience' were retained. In terms of the circadian/personality variables, 'locus of control' was positively correlated with 'flexibility' ($r_{(144)}$=.463, p<.001) whilst 'perceived sleep need' correlated positively with 'languidity' ($r_{(145)}$=.477, p<.001). Despite such findings, all variables within this category were retained. No variable within the work related category showed strong relationships with either each other or the remaining modifier variables, and therefore were retained in their existing form.

Table 9.4. Modifier variables used in further analysis

Demographic	Circadian/Personality	Work related
Age	Perceived sleep need	Control over job pacing
Marital status	Extroversion/Introversion	General Job Satisfaction
Number of dependants	Engagement	Perceived workload
Shiftwork experience	Locus of Control	
Commuting time	Languidity/Vigorousness	
	Flexibility/Rigidity	
	Morningness (TAQ)	
	Strength of early/late preferences	
	Time Awareness	

9.3.1.3. Effect of Time

The degree of participants' adaptation to the shift over time was analysed by means of paired samples t-tests of the outcome variables, comparing responses at T1 with those obtained at T2. Descriptive statistics and t-values are presented in Table 9.5, showing values for both the outcome factors (where derived) and their component items.

In terms of attitudes towards shiftwork, comparable results were found. Participants were more likely to feel that the advantages of shiftwork outweighed the disadvantages, and had stronger preferences for shiftwork over daywork at T2 compared to T1. However, in neither case was significance reached. Although the overall level of social and domestic disturbance showed a worsening over time, when broken down into its constituent components only the item relating to interference to leisure time was found to be more disruptive at T2. Again no change was found to be significant.

Whilst 'Psychological Health and Sleep' showed an overall improvement over time, on closer analysis only two of its component items were found to be less problematic at follow-up: cognitive fatigue ($t_{(38)}$=.157, p>.05) and cognitive anxiety ($t_{(39)}$=.213, p>.05). Despite the fact that all other variables within the factor showed a deterioration at T2, only two of these were found to be significantly worse; sleep quality between successive afternoon shifts ($t_{(23)}$=2.698, p<.05) and physical fatigue ($t_{(40)}$=2.474, p<.05).

Table 9.5. Descriptive statistics of outcome variables by time

	T1		T2		
	$\bar{x}$	(SD)	$\bar{x}$	(SD)	t
Advantages outweigh Disadvantages	3.15	(1.05)	3.25	(1.35)	0.448
Preference for Days over Shifts	3.70	(1.16)	3.68	(1.35)	0.133
Social and Domestic Interference	-0.04	(2.12)	4.87E-16	(2.15)	0.095
Interference with leisure time	3.80	(1.03)	3.83	(1.05)	0.124
Interference with domestic life	3.54	(1.21)	3.20	(1.08)	1.594
Interference with non-domestic life	2.56	(1.16)	2.44	(1.25)	0.597
Psychological Health and Sleep	0.32	(5.27)	0.07	(4.82)	0.442
Sleep quality between M shifts	14.67	(3.21)	15.15	(3.13)	1.150
Sleep quality between A shifts	12.13	(2.19)	13.38	(2.22)	**2.698***
Sleep quality between N shifts	15.61	(3.90)	15.82	(4.24)	0.625
Sleep quality between rest days	10.53	(2.11)	11.41	(2.80)	1.773
Sleep quality between quick returns	16.56	(3.31)	16.75	(2.74)	0.312
Cognitive Fatigue	17.26	(8.12)	17.10	(6.80)	0.157
Physical Fatigue	9.66	(2.16)	10.63	(2.53)	**2.474***
GHQ-12	23.22	(4.99)	23.24	(3.84)	0.042
Cognitive Anxiety	11.20	(4.76)	11.05	(4.28)	0.213
Somatic Anxiety	11.75	(4.53)	12.03	(4.37)	0.591
Neuroticism	11.68	(3.19)	11.68	(3.19)	-
On-shift alertness	31.22	(5.49)	29.87	(5.48)	1.858
Physical Health	0.23	(2.92)	-0.23	(2.92)	1.875
Gastrointestinal health	15.21	(4.23)	14.64	(4.70)	1.545
Minor infections	2.00	(0.77)	1.88	(0.78)	1.152
Cardiovascular health	10.95	(3.42)	11.30	(3.35)	1.096
Musculoskeletal pain	9.39	(3.12)	9.46	(3.01)	0.206
Sleep Duration:					
Between successive M shifts	6.33	(0.80)	6.56	(1.19)	1.412
Between successive A shifts	8.00	(1.12)	7.77	(1.17)	1.487
Between successive N shifts	5.80	(1.25)	5.77	(1.22)	0.014
Between successive rest days	8.87	(1.04)	8.62	(1.52)	0.963
Between a quick return	5.62	(0.83)	5.63	(0.96)	0.025

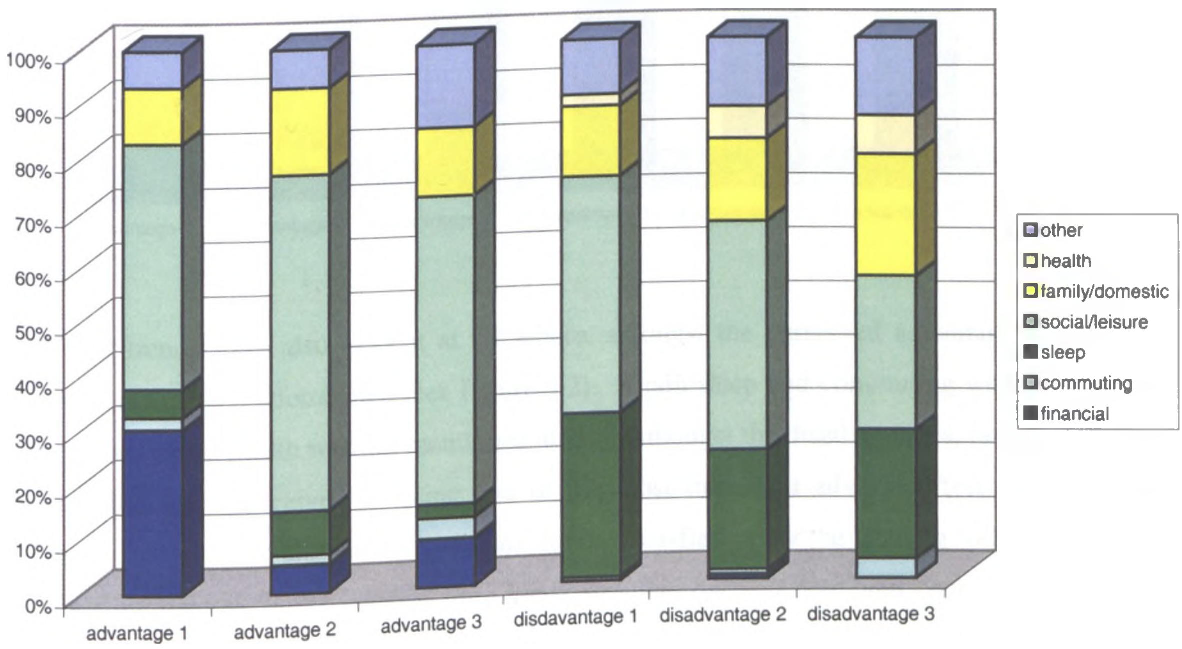
***p<.001; ** p<.01; * p<.05

Scores derived for physical health showed mixed results. Whilst participants perceived themselves to suffer more symptoms related to cardiovascular health and the experience of musculoskeletal pain at T2, scores on the two remaining subscales (gastrointestinal and minor infections) showed an improvement of symptoms over time. Nevertheless, no comparisons were found to be significantly different, and the factor showed an improvement of problems over time. Finally, for sleep duration, only the number of hours sleep gained between two successive morning shifts or between a quick return were found to increase at follow-up, whilst sleep duration between successive afternoon and night shifts and between successive rest days was found to decrease. Supporting the overall trend, no significant differences emerged.

Perceived Advantages and Disadvantages of Shiftwork

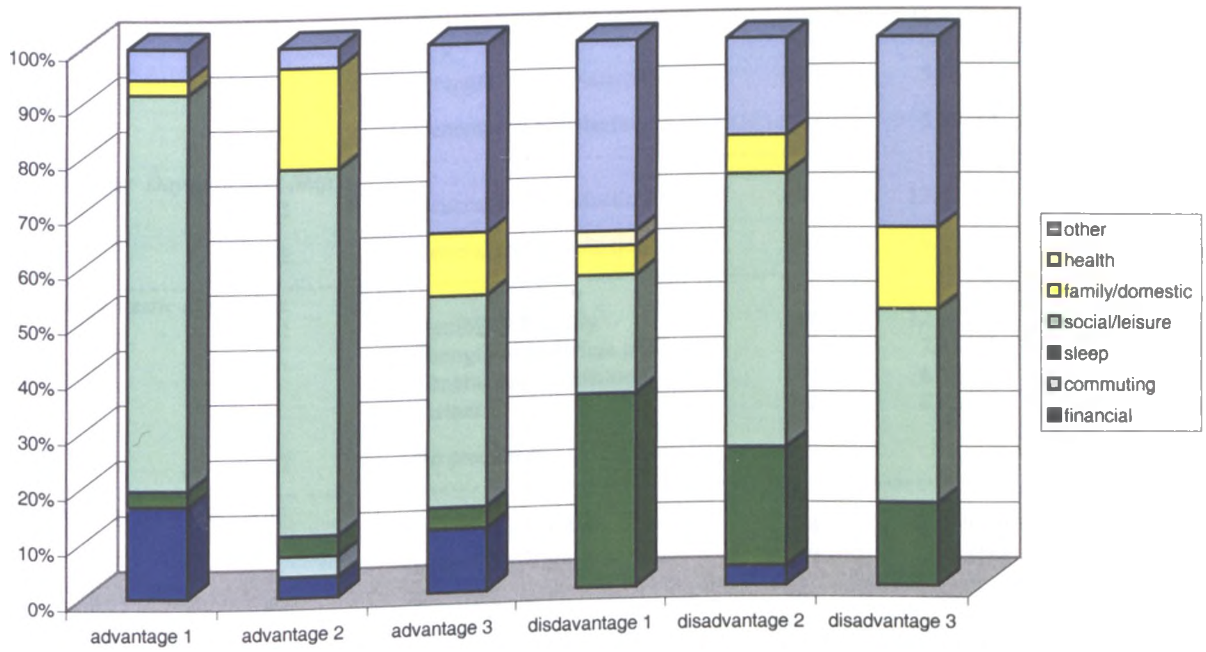
In order to examine the perceived advantages and disadvantages of shiftwork in a manner uncontaminated by the specific wording of questions, respondents were given three text boxes and asked "What are the three main advantages of your shift system for you?". This was repeated for the perceived disadvantages. These responses were classified into major domains, with no attempt to match outcome variables employed in the survey. The findings are illustrated in Figures 9.1 and 9.2.

Figure 9.1. Perceived advantages and disadvantages at T1 amongst automobile plant workers



As with Chapter 6, the effect of the shift on social and leisure activities were clearly evident amongst both the perceived advantages and disadvantages, predominating amongst all responses given. Financial rewards offered by the rotating system were also prominent here, although positive effects on family and domestic life were also reported. In contrast, commuting time received little attention, and health was not mentioned at all. In terms of the perceived disadvantages of the shift system, after social and leisure activities, sleep was frequently listed, with such remarks as "*having to get up for the early shift*" and "*constantly feeling tired*" recurring throughout the data. There was also a slight increase in comments relating to family and domestic life. Moreover, problems with health and eating behaviour only occurred under the disadvantages section.

Figure 9.2. Perceived advantages and disadvantages at T2 amongst automobile plant workers



Similar trends were also evident at T2 where, amongst the perceived advantages, social and leisure activities predominated (see Figure 9.2). Again sleep and commuting were reported by very few, whilst health was not mentioned at all. Amongst the disadvantages, fatigue and sleep disruption were perceived as being one of the most important adverse effects of shiftwork, comparable to social and leisure activities. Items classified under the heading 'other' containing such comments as "*work involves long hours standing on your feet*" and "*constantly changing shift schedule*" were also represented.

9.3.1.4. Multivariate Analysis

In order to examine the predictive validity of the modifier variables, a series of regression analyses were performed, where modifiers were treated as independent variables with each of the outcomes being entered in turn as the dependent variable. Following the same strategy as previous chapters, in the first instance, a statistically driven model was derived for each of the outcome variables whereby all modifiers were entered together in a stepwise method. Following this, theoretically driven models were derived, using the modifiers as blocks of related predictors. As before, in order to investigate the predictive power of each category of modifiers without the influence of covariates, each block was entered on its own. These results were then compared when the 3 blocks were entered into the regression model sequentially, in the order: demographic, circadian/personality, work related. Separate regression analyses were performed for T1 and T2. The following section summarises the results of this analysis. Summary statistics are presented in Tables 9.6, 9.7 and 9.8, overpage.

Table 9.6. Summary statistics for stepwise regression amongst automobile plant workers

		Predictors	R^2 change	F change	df	β
Advantages outweigh Disadvantages:						
	T1	General Job Satisfaction	.194	31.060***	1,129	.372***
		LOC	.057	9.718**	1,128	.221**
		Strength of early/late pref.	.029	5.167*	1,127	-.173*
	T2	General Job Satisfaction	.187	8.987**	1,39	.433**
Preference for Daywork over Shifts:						
	T1	General Job Satisfaction	.121	17.829***	1,129	-.348***
	T2	General Job Satisfaction	.196	9.509**	1,39	-.443**
Social & Domestic Disruption:						
	T1	Flexibility/Rigidity	.088	12.383***	1,129	-.191*
		Strength of early/late pref.	.051	7.534**	1,128	.248**
		General Job Satisfaction	.041	6.361*	1,127	-.238**
		Partner	.042	6.726*	1,126	.207*
	T2	No predictors	-	-	-	-
Psychological Health & Sleep:						
	T1	Flexibility/Rigidity	.234	36.729***	1,120	-.374***
		Languidity/Vigorousness	.099	17.742***	1,119	.334***
	T2	Extroversion	.203	6.890*	1,27	-.491***
		Languidity/Vigorousness	.139	5.518*	1,26	.354*
		Time Awareness	.140	6.786*	1,25	.394**
		Engagement	.087	4.887*	1,24	-.298*
Physical Health:						
	T1	Flexibility/Rigidity	.134	20.027***	1,129	-.266***
		Shift experience	.053	8.291**	1,128	.234**
		Strength of early/late pref.	.035	5.717*	1,117	.220**
		Languidity/Vigorousness	.044	7.517**	1,116	.224**
	T2	LOC	.227	8.498**	1,29	-.471**
		Workload	.183	8.662**	1,28	.428**
Sleep Length:						
Between successive M shifts						
	T1	Flexibility/Rigidity	.086	10.970***	1,117	-.257**
		Perceived sleep need	.031	4.024*	1,116	.202*
		Age	.037	5.016*	1,115	-.194*
	T2	Flexibility/Rigidity	.182	8.663**	1,39	-.426**
Between successive A shifts						
	T1	Languidity/Vigorousness	.046	6.048*	1,125	.212*
		Commuting time	.041	5.616*	1,124	-.203*
	T2	Perceived sleep need	.185	4.999*	1,22	.430*
Between successive N shifts						
	T1	Morningness	.033	4.431*	1,129	-.195*
		Flexibility/Rigidity	.032	4.365*	1,128	.179*
	T2	Age	.113	4.822*	1,38	-.336*
Between successive rest days						
	T1	Languidity/Vigorousness	.111	15.398***	1,123	.234***
	T2	Perceived sleep need	.178	8.255**	1,38	.422**
Between a quick return						
	T1	No predictors	-	-	-	-
	T2	No predictors	-	-	-	-

*** p<.001; ** p<.01; * p<.05

Table 9.7. Summary statistics for hierarchical regression (individual blocks) amongst automobile plant workers

	Demographic		Circadian/Personality		Work related	
	R^2	F	R^2	F	R^2	F
Advantages outweigh Disadvantages:						
T1	.044	1.224	**.243**	**4.313*** **	.202	11.836***
T2	.085	0.689	.134	0.535	**.217**	**3.686***
Preference for Daywork over Shifts:						
T1	.053	1.493	**.133**	**2.064***	.129	6.936***
T2	.089	0.722	**.332**	**1.708**	.217	3.694*
Social & Domestic Disruption:						
T1	.067	1.909	**.181**	**2.973** **	.096	4.977**
T2	.171	1.115	**.417**	**1.751**	.090	0.991
Psychological Health & Sleep:						
T1	.018	0.439	**.359**	**6.965*** **	.112	5.272**
T2	.105	0.542	**.602**	**3.199**	.132	1.322
Physical Health:						
T1	.104	3.039*	**.261**	**4.759*** **	.074	3.610*
T2	.254	1.771	**.482**	**2.175**	.311	4.372*
Sleep Length:						
Between successive M shifts						
T1	.029	0.691	**.158**	**2.266***	.059	2.541
T2	.052	0.404	**.315**	**1.582**	.063	0.890
Between successive A shifts						
T1	.074	2.019	**.112**	**1.632**	.003	0.112
T2	.124	0.539	**.512**	**1.629**	.009	0.064
Between successive N shifts						
T1	.058	1.593	**.124**	**1.899**	.022	1.019
T2	**.129**	**1.008**	.117	0.440	.024	0.298
Between successive rest days						
T1	.022	1.019	**.155**	**2.334***	.015	0.630
T2	.180	1.532	**.225**	**0.956**	.051	0.687
Between a quick return						
T1	**.102**	**2.089**	.037	0.355	.007	0.230
T2	.015	0.044	**.252**	**0.337**	.031	0.171

*** p<.001; ** p<.01; * p<.05

Table 9.8. Summary statistics for hierarchical regression (sequentially) amongst automobile plant workers

	Demographic		Circadian/Personality		Work related	
	R^2	F	R^2 change	F change	R^2 change	F change
Advantages outweigh Disadvantages:						
T1	.044	1.141	**.237**	**4.239*** **	**.083**	**4.937** **
T2	.085	0.652	.152	0.576	.125	1.504
Preference for Daywork over Shifts:						
T1	.053	1.393	**.132**	**2.091***	**.078**	**4.002** **
T2	.089	0.683	.362	1.907	.043	0.657
Social & Domestic Disruption:						
T1	.067	1.781	**.180**	**3.083** **	.032	1.675
T2	.171	1.074	.323	1.206	.008	0.074
Psychological Health & Sleep:						
T1	.018	0.424	**.351**	**6.621*** **	.015	0.823
T2	.105	0.542	**.577**	**2.826***	.083	1.292
Physical Health:						
T1	.104	2.899*	**.225**	**4.325*** **	.012	0.675
T2	.254	1.703	.394	1.987	**.188**	**4.987***
Sleep Length:						
Between successive M shifts						
T1	.029	0.667	**.166**	**2.389***	.013	0.551
T2	.052	0.382	.325	1.508	.074	1.032
Between successive A shifts						
T1	.074	1.923	.124	1.914	.008	0.369
T2	.124	0.511	.455	1.083	.076	0.439
Between successive N shifts						
T1	.058	1.506	.109	1.694	.032	1.487
T2	.129	1.008	.121	0.449	.056	0.587
Between successive rest days						
T1	.021	0.503	**.147**	**2.165***	.017	0.729
T2	.180	1.488	.200	0.893	.029	0.357
Between a quick return						
T1	.102	1.998	.044	0.451	.017	0.506
T2	.015	0.041	.259	0.159	.035	0.017

*** p<.001; ** p<.01; * p<.05

Perceived Advantages of Shiftwork

When asked whether the advantages of shiftwork outweighed the disadvantages, the 'level of contentment and satisfaction with the job' emerged as the strongest predictor at both T1

(R^2=.194, F=31.060, p<.001) and T2 (R^2=.187, F=8.987, p<.01). Positive ß-weights in both cases suggested that greater general job satisfaction was associated with the perception that the advantages of shiftwork were more important than it's disadvantages. However, whilst this was the only variable to enter the equation for T2, at T1 a tendency toward 'internality' (R^2=.057, F=9.718, p<.01; ß=221, p<.01) and weak 'early/late preferences'(R^2=.029, F=5.167, p<.05; ß=-.173, p<.05) also arose as predictors (see Table 9.6).

At T1, when entered as a single block, demographic variables predicted the least amount of variance overall at just 4.4% (F=1.224, p>.05), whilst circadian/personality variables predicted the highest proportion at 24.3% (F=4.313, p<.001). Work related variables accounted for a similar amount at 20.2% (F=11.836, p<.001) (see Table 9.7). Hierarchical multiple regression to eliminate the influence of covariates supported the sequential model, where, after the entry of demographic variables in step 1, circadian/personality variables in step 2 significantly improved the prediction of the perceived advantages of shiftwork (R^2 change=.237, F change=4.239, p<.001), a finding mirrored with work related variables entered in step 3 (R^2 change=.083, F change=4.937, p<.05). In this final model, four modifiers were found to add significantly to the solution. In order of importance these were, 'satisfaction and contentment with the job', 'morningness', 'flexibility' and 'strength of early/late preferences' (see Table 9.8).

In contrast, at T2, when entered as a single block work related variables proved to be the strongest, accounting for 21.7% (F=3.686, p<.05), being the only category to produce a significant equation. Inspection of the ß statistics supported the stepwise model with 'general job satisfaction' being the only variable within this category to achieve a significant ß-weight (ß=.453, p<.01). For the remaining categories, circadian/personality variables predicted 13.4% (F=0.535, p>.05) with demographic variables being the weakest overall, explaining just 8.5% (F=0.689, p>.05). Hierarchical analysis revealed that after the entry of demographic modifiers in step 1, neither circadian/personality variables (step 2) nor work related variables (step 3) significantly improved the predictive power of the model.

Summary

Thus, taken together the findings suggest that, of the categories of modifiers, those in the circadian/personality category were stronger at T1, whilst at T2, those in the work related category were more important. For example, at T1 although general job satisfaction predicted the largest proportion of variance in stepwise analysis, when tested in individual blocks, the circadian/personality category was strongest overall (although, like circadian/personality modifiers, work related variables also predicted over 20% of the variance). Furthermore, when tested in the sequential model, the introduction of circadian/personality variables increased the predictive power of the equation and showed little attenuation by the demographic group. Yet the two taken together had a strong impact on work related modifiers, reducing their power from 20.2% when tested alone to 8.3%, when entered in the final step.

In contrast, at T2 work related variables predominated, being the only category to be entered into the stepwise analysis, predicting the most variance when tested alone, and being the only category to result in a significant equation. However, the decrease in power in the sequential model when the remaining categories had been held constant suggested that there was some interaction between the three groups in the prediction of workers' attitudes toward shiftwork.

Preference for Daywork over Shifts

In terms of a preference for daywork over shifts, 'satisfaction and contentment with the job' emerged as the only predictor at both T1, accounting for 12.1% of the variance ($F=17.829$, $p<.001$) and at T2, accounting for 19.6% ($F=9.509$, $p<.01$). A negative ß-weight in both cases supported the trend noted for perceived advantages of shiftwork, where greater satisfaction was associated with a more favourable attitude (T1: $\beta=-.348$, $p<.001$; T2: $\beta=-.443$, $p<.01$).

At T1, when entered as a single block, demographic variables predicted 5.3% of the total variance ($F=1.493$, $p>.05$), whilst circadian/personality and work related modifiers predicted similar amounts; 13.3% ($F=2.064$, $p<.05$) for the former, and 12.9% ($F=6.936$, $p<.001$) for the latter. At T2, a similar picture arose with the highest proportion of variance being explained by circadian/personality modifiers ($R^2=.332$, $F=1.708$, $p>.05$), followed by those within the work related category ($R^2=.217$, $F=3.694$, $p<.05$). As at T1, demographic variables were the weakest category overall ($R^2=.089$, $F=0.722$, $p>.05$).

Hierarchical analysis on both T1 and T2 data showed that, after the entry of demographic modifiers in step 1, circadian/personality modifiers in step 2 improved the significance of the equation (T1: R^2 change=.132, F change=2.091, $p<.05$: T2: R^2 change=.362, F change=1.907, $p>.05$), as did work related variables in step 3 (T1: R^2 change=.078, F change=4.002, $p<.01$; T2: R^2 change=.043, F change=0.657, $p>.05$), although the final step was significant for T1 results only. Inspection of the final model showed that 'satisfaction and contentment with the job' (the most important predictor according to stepwise analysis) yielded a significant ß-weight, yet both 'shiftwork experience' and 'age' were of a greater magnitude. At T2, 'time awareness' was the only variable to achieve significance.

Summary

As with the previous attitude item, stepwise analysis suggested that work related variables were most important, with general job satisfaction being the only variable to emerge at both time points. However, when the groups of variables were entered in individual blocks, circadian/personality modifiers yielded the most predictive power. This was further underlined in the hierarchical approach where work related variables achieved significance at both baseline and follow-up when entered in isolation. However, when entered sequentially, circadian/personality variables showed little mediation by the demographic group, but taken together the two exerted strong mediating effects on work related variables, decreasing their power by 5.1% (T1) and 17.4% (T2) when tested sequentially.

Social and Domestic Disruption

In terms of social and domestic disruption, four modifiers were extracted at T1, with variables from each of the three categories emerging as predictors. The strongest of these was 'flexibility' (R^2=.088, F=12.383, p<.001) where a negative ß-weight (-.191, p<.05) suggested that those who were rigid in their sleeping habits suffered more disruption. Accounting for similar proportions, having strong early/late preferences (R^2 change .051, F change=7.534, p<.01; ß=.248, p<.05), being less satisfied with the job (R^2 change=.041, F change=6.361, p<.05; ß =-.238, p<.01) and having a partner (R^2 change=.042, F change=6.726; ß=.207, p<.05) were all associated with greater interference to social and domestic activities. As with previous chapters, no predictors emerged at T2.

When entered as a single block, demographic variables accounted for the least amount of variance in social and domestic interference at T1 (R^2=.067, F=1.909, p>.05). Work related variables accounted for 9.6% (F=4.977, p<.01), although the circadian/personality category was by far the strongest, explaining nearly double this at 18.1% (F=2.973, p<.01). Hierarchical analysis showed the predictive power of the model to be significantly improved after the entry of circadian/personality modifiers in step 2 only (R^2 change=.180, F change=3.083, p<.01), with only two modifiers entering the final model: 'strength of early/late preferences' (ß=.242, p<.01) and 'satisfaction and contentment with the job' (ß=-.209, p<.05).

At T2 a different pattern of results were found. Although circadian/personality variables remained the most important of the three categories, explaining 41.7% (F=1.751, p>.05) of the total variance, work related variables were weakest, explaining only 9% (F=0.991, p>.05). Despite this, no category resulted in a significant equation. This was further underlined through hierarchical analysis where neither the entry of circadian/personality modifiers in step 2, nor work related modifiers in step 3, significantly increased the predictive power of the model.

Summary

In summary, the results suggest that circadian/personality variables were the most important in the prediction of social and domestic disruption amongst this cohort, although the effect was stronger at T1. For example, in stepwise analysis, flexibility emerged as the strongest predictor (T1 only), whilst the circadian/personality group accounted for the highest proportion of variance overall when tested alone (T1 and T2), it was the only category to improve the prediction of disruption when entered hierarchically.

Psychological Health and Sleep

When all modifiers were entered in a stepwise model, a contrasting picture was found for psychological health and sleep problems at baseline and follow-up. At T1 the two circadian variables of 'flexibility' and 'languidity' were extracted, between them accounting for 33.3% of the variance. 'Flexibility' was by far the strongest predictor overall, by itself accounting for 23.4% ($F=36.729$, $p<.001$). A negative ß value suggested that a tendency toward rigidity was associated with greater problems. 'Languidity', contributing 9.9% ($F=17.742$, $p<001$), had a positive ß-weight of .334 ($p<.001$) indicating that those who found it difficult to overcome drowsiness experienced greater psychological health and sleep problems.

In contrast, at T2 'extroversion' emerged as the most important predictor of psychological health and sleep, accounting for 20.3% of the variance overall ($F=6.890$, $p<.05$). Here ß=-.491 ($p<.001$) suggested that those with a more introverted nature suffered more problems. Additional predictor variables also emerged at T2, with the pattern of results suggesting that individuals who found it difficult to overcome drowsiness, (R^2 change=.139, F change=5.518, $p<.05$; ß=.354, $p<.05$), who were able to tell the time without reference to a clock or a watch (R^2 change=.140, F change=6.786, $p<.05$; ß=.394, $p<.01$) and who preferred to use disengagement strategies in coping with their problems (R^2 change=.087, F change=4.887, $p<.05$; ß=-.298, $p<.05$), suffered more problems in this area.

Entering the modifiers in individual blocks revealed that, at both T1 and T2, circadian/personality variables proved to be the strongest predictors of psychological health and sleep problems, explaining 35.9% ($F=6.965$, $p<.001$) and 60.2% ($F=3.199$, $p>.05$) respectively. This was followed by work related variables, explaining 11.2% ($F=5.272$, $p<.01$) and 13.2% ($F=1.322$, $p>.05$) respectively. In both cases demographic variables failed to reach significance. The similarity was further underlined when the variables were entered sequentially, where, in both cases, the predictive power of the model was significantly increased with the addition of circadian/personality modifiers in step 2 (T1: R^2 change=.351, F change=6.621, $p<.001$; T2: R^2 change=.577, F change=2.826, $p<.05$). Work related variables in step 3 failed to do so (T1: R^2

change=.015, F change=.823, p>.05; T2: R^2 change=.083, F change=1.292, p>.05). In support of the stepwise approach, analysis of the final equations showed 'languidity' (ß=.400, p<.001) and 'flexibility' (ß=-.336, p<.001) to be the only modifiers to be entered into the model for T1, whilst at T2, 'extroversion' (ß=-.602, p<.05) and 'time awareness' (ß=.419, p<.05) were the only variables to achieve significance.

Summary

In summary, despite the fact that different predictors emerged in stepwise analysis at each time point, when entered as individual blocks, circadian/personality variables, followed closely by work related variables, were the strongest predictors of psychological health and sleep problems at both T1 and T2. The predominance of circadian/personality modifiers was further underlined through hierarchical analysis where, after holding demographic variables constant, they significantly increased the predictive power of the equation, suggesting that the former had little mediating influence upon them. In contrast the fact that work related variables entered in step 3 failed to show a significant difference suggested that modifiers within the previous two categories weakened their unique contribution.

Physical Health

At T1, 4 modifiers emerged as predictors of physical health that between them accounted for 26.6% of the variance. The most important of these was 'flexibility' accounting for 13.4% (F=20.027, p<.001) where ß=-.266 (p<.001) indicated that individuals who were flexible in their sleeping habits suffered fewer physical health problems. Additionally those with more 'shiftwork experience' (R^2 change=.053, F change=8.291, p<.01; ß=.234, p<.01), stronger preferences as to the time of day at which they performed certain activities (R^2 change=.035, F change=5.717, p<.05; ß=.220, p<.01) and who were languid in their ability to overcome drowsiness (R^2 change=.044, F change=7.517, p<.01; ß=.224, p<.01) experienced greater problems.

In support of the stepwise model, when entered as single blocks, circadian/personality variables emerged as the strongest predictors at T1, explaining 26.1% (F=4.759, p<.001), whilst work related variables accounted for the least at 7.4% (F=3.610, p<.05). Demographic variables ranked between the two, contributing 10.4% overall (F=3.039, p<.05). As can be seen in Table 9.7, all 3 blocks of variables resulted in a significant equation. Hierarchical analysis showed that after the entry of demographic modifiers in step 1, the predictive power of the model was significantly increased with the entry of circadian/personality modifiers in step 2 (R^2 change=.225, F change=4.325, p<.001). The addition of work related variables in step 3 failed to do the same (R^2 change=.012, F change=0.675, p>.05).

Interestingly two different predictors were extracted during stepwise analysis at T2. Here, 'internality' was the stronger of the two, accounting for 22.7% of the variance (F=8.498, p<.01) with a negative ß-weight (ß=-.471, p<.01) indicating that believing outcomes of a situation to be contingent upon personal attributes resulted in fewer physical health problems. 'Workload' contributed a further 18.3% (F change=8.662, p<.01) where ß=.428 (p<.01) suggested that more physical health symptoms were reported by those who perceived themselves to have a high workload.

As at T1, when entered as individual blocks circadian/personality modifiers explained the greatest proportion of variance in physical health, predicting 48.2% (F=2.175, p>.05), with work related variables explaining 31.1% (F=4.372, p<.05) and demographic variables the least at 25.4% (F=1.771, p>.05). However, in contrast only the work related variables when entered as a single block resulted in a significant equation. In terms of hierarchical analysis, after the entry of demographic variables in the first step, circadian/personality variables in the second explained a further 39.4% (F change=1.987, p>.05). Work related variables in the third step further increased the predictive power of the model, with a unique contribution of 18.8% (F change=4.987, p<.05). Significance was only achieved in step 3.

Summary

As with psychological health and sleep above, for physical health a different pattern of predictors emerged at each of the time points. Whilst circadian/personality modifiers were found to be strongest at T1, both circadian/personality and work related variables were important at T2. At T1 the strength of circadian/personality modifiers emerged in stepwise analysis where 3 of the 4 variables entered in the equation were derived from this category. Moreover, when tested alone, circadian/personality modifiers accounted for the highest proportion of variance and, when entered sequentially, was the only category to improve the prediction of physical health. In contrast at T2, stepwise analysis yielded a mixture of both circadian/personality and work related modifiers. This trend was further supported in the theoretically driven models. When entered as individual blocks, the circadian/personality category prevailed, although in support of the stepwise equations, were closely followed by those in the work related group. When entered sequentially only the addition of work related variables increased the predictive power of the model.

Sleep Duration

At T1, when all modifiers were entered into a stepwise analysis, 'flexibility', 'perceived sleep need' and 'age' emerged as predictors of sleep duration between successive morning shifts. Here those with flexible sleeping habits (R^2=.086, F=10.970, p<.001; ß=-.257, p<.01), long sleepers (R^2 change=.031, F change=4.024, p<.05; ß=.202, p<.05) and younger workers (R^2 change=.037, F change=5.016, p<.05; ß=-.194, p<.05) obtained more sleep. At T2 only 'flexibility' entered the model (R^2=.182, F=8.663, p<.01) where, as at T1, ß=-.426 (p<.01) suggested that flexible sleeping habits were indicative of more sleep.

For sleep length between successive afternoon shifts, difficulties in overcoming drowsiness (R^2=.046, F=6.048, ß=.212, p<.05) and a longer commuting time (R^2 change=.041, F change=5.616, p<.05; ß =-.203, p<.05) were extracted at T1, whilst at T2, only 'perceived sleep need' emerged (R^2=.185, F=4.999, p<.05). ß=.430 (p<.05) suggested that being a longer sleeper was indeed associated with more sleep. However, since such a conclusion is based on purely subjective responses there is no guarantee that longer sleepers actually gained more sleep, since it may be the case that needing more sleep is associated with the *perception* of achieving adequate rest.

Two circadian variables were the only predictors extracted for the length of sleep between successive night shifts at T1. Here 'morningness' accounted for 3.3% of the variance (F=4.431, p<.05) whilst 'flexibility' accounted for a similar proportion at 3.2% (F change=4.365, p<.05). Inspection of the ß statistics revealed that a tendency toward eveningness (ß=-.195, p<.05) and the ability to sleep at different times of the day and night (ß=.179, p<.05) were associated with more sleep. At T2 the demographic variable of 'age' was extracted as the only predictor of sleep length between night shifts. Here ß=-.336 (p<.05) suggested that younger workers gained more sleep.

In keeping with the circadian theme, sleep duration between successive rest days was predicted by only one modifier at T1, that of 'languidity'. Accounting for 11.1% of the variance (F=15.398, p<.001), ß=.234 (p<.001) indicated that those who found it difficult to overcome drowsiness tended to sleep more during their days off. At T2, only 'perceived sleep need' was extracted in a model that accounted for 17.8% of the variance (F=8.255, p<.01). Here long sleepers obtained more sleep (ß=.422, p<.01). Stepwise regression on sleep duration between quick returns failed to result in an equation at either T1 or T2, possibly due to the small number of responses gained on this item.

Inspection of both the theoretically driven and statistically driven models revealed a common trend. Neither demographic nor work related variables significantly predicted sleep length during either work or rest days (see Table 9.7). Indeed only 2 significant equations emerged overall, occurring amongst circadian/personality variables and at T1 only. Circadian/personality modifiers were found to predict sleep duration between successive morning shifts (R^2=.158,

$F=2.266$, $p<.05$) and between successive rest days ($R^2=.155$, $F=2.334$, $p<.05$). Furthermore, when the groups of modifiers were entered in individual blocks, the circadian/personality category accounted for the greatest proportion of variance in all but two cases (with demographic variables being stronger in the prediction of sleep length between successive night shifts at T2 and between a quick return at T1).

This theme was also carried through the results of hierarchical analysis, where significant increases in the predictive power of the equation were found amongst circadian/personality variables (at T1 only). Thus, as can be seen from Table 9.8, after the entry of demographic variables in step 1, circadian/personality modifiers in step 2 significantly increased the predictive power of the equation between successive morning shifts (R^2 change=.166, F change=2.389, $p<.05$) and between successive rest days (R^2 change=.147, F change=2.165, $p<.05$). In all cases the addition of work related variables in step 3 failed to yield a significant change.

Summary

The evidence above suggests that both circadian/personality and demographic variables played a role in the prediction of sleep length between successive shifts and rest days. Stepwise analysis extracted variables within these categories only, and when tested in isolation, circadian/personality modifiers accounted for the highest proportion of variance (with the exception of two instances), yielding the only equations to reach significance. Demographic variables were the second strongest in the majority of cases. When analysed sequentially, circadian/personality variables showed little attenuation by those in the demographic group, although interestingly, despite the weakness of work related variables throughout the analysis, they appeared to be enhanced when the effects of demographic and circadian/personality variables were held constant. This suggested that the two taken together strengthened work related modifiers.

9.4. Discussion

The main aims of the present study were (1) to explore the relationships between outcomes and modifiers, comparing these with previous chapters, and (2) to explore whether these relationships held over time.

Factor analysis of outcome variables replicated several of the factor structures derived in Chapters 6 and 7, with both the psychological health and sleep and physical health factors being supported. On the former, a similar trend was found in relation to on-shift alertness, included here in the absence of items relating to perceived risk, showing a low loading and decreased scale reliability. Likewise, as in Chapter 6, for physical health, the single item relating to minor infections had the lowest loading of all 4 subscales and was found to reduce the total scale alpha.

Correlations between outcome variables also revealed familiar trends, where, with the exception of sleep length between a quick return, each outcome variable at T1 significantly correlated with scores at T2. Thus, despite factor analysis not being performed separately on T2 scores, due to a reduction in the sample size, the structures at T1 nevertheless held over time. Moreover, as with Chapter 8, two main clusters of correlations were clearly evident, one between measures of sleep length and one between all other outcome variables, with little cross-over between the two. A strong correlation existed between attitudes towards shiftwork and social and domestic interference (consistent throughout the research), although, as with Chapter 8, the relationship was stronger for the preference for daywork measure. For both items a less positive attitude toward shiftwork was related to greater impairment to social and domestic life. Given the strong association between these items it was perhaps not surprising to find these two to be the only outcome variables (apart from measures of sleep length) to be associated with the length of sleep between successive rest days, although this was true of sleep at T2 only. Positive correlations in both cases indicated that a stronger preference for daywork over shifts and greater social and domestic disruption were associated with more sleep, a similar finding to the previous chapter.

Analysis of outcomes over time revealed contrasting results to those of the short-term study discussed in the previous chapter, in which a worsening of all outcome variables (except physical health, alertness and safety and a preference for daywork) after 5 weeks was revealed. In contrast, analysis of outcomes over the 12 month period revealed an improvement in both attitude measures, psychological health and sleep, physical health, and an increased sleep length between successive morning shifts and between a quick return. Only social and domestic interference showed a worsening over time. Sleep lengths between successive afternoons, nights and rest days also decreased between T1 and T2. However, although changes occurred on all variables considered, the magnitude of change was small (e.g. social and domestic disruption saw a worsening of problems from –0.04 at T1 to 4.87E-16 at T2), emphasised by the paucity of significant t-values.

Stepwise regression revealed predictive relationships for almost all outcome measures, but, as with Chapter 8, few were constant over time. 'General job satisfaction' entered the equation at T1 and T2 on both attitude items, where for the preference for daywork measure it was the only predictor to emerge at each time point. Similarly, 'languidity/vigorousness' was the only modifier to be extracted at both time points for psychological health and sleep, whilst for the length of sleep between successive morning shifts the related variable of 'flexibility/rigidity' was extracted.

As with previous chapters, strongly correlated outcomes showed the most similarities in terms of the predictors extracted, although this was moreso for T1 equations. For example, the two health measures were strongly positively correlated at both T1 (.529, $p<.001$) and T2 (.636, $p<.001$). At T1 the circadian variables of 'flexibility' and 'languidity' were extracted for both psychological health and sleep and physical health, occurring in the same order of magnitude. Different predictors emerged on each outcome at T2. Similarly, 'strength of early/late preferences' entered the equations for the perceived advantages of shiftwork (T1) and social and domestic interference (T1), whilst 'general job satisfaction' was extracted for both attitude measures and social and domestic disruption.

Although very few relationships were consistent across all 4 studies, a number of similarities with the results gained here were noted. Attitude toward shiftwork measures supported Chapter 6 where 'general job satisfaction' and 'internality' were extracted in the same order for both studies. The strong work related theme also partially supported Chapter 7 where 'control over shifts' was extracted for all shift types. Similarly, for social and domestic interference, 'flexibility' was found to be the strongest predictor overall, as was the case in Chapter 7 amongst those working rotating shifts with nights and permanent nights. 'General job satisfaction' accounted for a similar proportion of variance here as in Chapter 6 (R^2=.041 and R^2=.046, respectively), although again the related modifier of 'control over shifts' was seen amongst only the rotating without nights and permanent morning groups of Chapter 7.

Circadian modifiers were by far the most important predictors for both health measures. 'Flexibility' and 'languidity' (both extracted at T1) were also found in the previous chapter, whilst in Chapter 6 only 'languidity' was extracted. 'Extroversion' and 'languidity' (extracted here at T2) again supported Chapter 6, although here the trend was reversed with 'languidity' being the stronger modifier. Extroversion was also found at follow-up in Chapter 8. In terms of T1 physical health, 'flexibility' was consistently extracted, being the most important predictor overall here, in the previous chapter and in Chapter 7 (derived for all 4 groups but strongest for groups working nights as part of their shift system). Although a number of additional variables emerged here, 'languidity' was the only one to be found elsewhere, as was 'internality' at T2 (Chapter 6). The strength of work related variables in the prediction of physical health was underlined by the extraction of 'workload' here, 'control over job pacing' in Chapter 8, 'control over shifts' in Chapter 7, and 'job demand' in Chapter 6. Measures of sleep length between successive shifts showed most similarities with Chapter 7, where most similarities were in accordance with those working rotating shifts with nights and/or permanent nightworkers on all items.

Circadian/personality modifiers proved to be the most important group of predictors at both T1 and T2, regardless of the specific outcome measure involved. Entering modifiers in individual blocks showed clear patterns of predictors, with the C-W-D and C-D-W trends predominating at both T1 and T2 (see Table 9.9). As with the stepwise analysis, similar patterns were generally found amongst outcomes that correlated highly with one another, although this was not always the case. Attitudes toward shiftwork, social and domestic interference and sleep between successive mornings had predictors in the order C-W-D. However, at T2, only preference for daywork and sleep length between successive morning shifts showed the same pattern. In contrast psychological health and sleep and physical health had different patterns at T1 but the same at T2.

Table 9.9. Summary of trends in hierarchical regression (individual blocks)†‡ amongst automobile plant workers

	T1	T2
Perceived advantages of shiftwork	C – W – D	W – C – D
Preference for daywork	C – W – D	C – W – D
Social and domestic interference	C – W – D	C – D – W
Psychological health and sleep	C – D – W	C – W – D
Physical health	C – W – D	C – W – D
Sleep length:		
Morning	C – W – D	C – W – D
Afternoon	C – D – W	C – D – W
Night	C – D – W	C – D – W
Quick return	D – C – W	C – W – D
Rest days	C – D – W	C – W – D

D=Demographic; C=Circadian/Personality; W=Work
† predictors presented in order of importance in all cases
‡ reflects higher impairments in all outcome measures

In terms of consistency over time, trends were stronger than the previous chapter with identical patterns occurring at both time points for a preference for daywork, psychological health and sleep and sleep length between successive mornings, afternoons and nights. Where patterns changed over time, circadian/personality modifiers nevertheless remained the strongest set of predictors overall. Trends found here only partially supported those of previous chapters, with few complete patterns concurring across studies. The W-C-D pattern revealed for T2 perceived advantages matched that found in Chapter 6, as did the C-W-D pattern for T1 social and domestic interference. The C-W-D pattern derived here for physical health also matched that found in Chapter 6. Only two patterns matched those found in Chapter 7: T1 physical health (amongst the rotating with nights and permanent nights groups only) and the length of sleep between successive afternoon shifts at both the initial testing and follow-up stages (amongst those working rotating shifts with nights). In terms of the previous chapter, the C-D-W pattern found here at T2 social and domestic interference supported that found at both time points, whereas the C-W-D found to be consistent over time here was typical of that found at initial testing of Chapter 8. For physical health the patterns of prediction were reversed with the T1 trend matching that found at follow-up in Chapter 8 and T2 matching that found at T1.

Entering categories of modifiers in the hypothesised direction of effects (demographic, circadian/personality, work-related) showed varying results. Whilst the addition of each set of modifier variables showed an increase in the majority of outcome variables at T1 (not supporting the predictions), at T2 few increases were evident (endorsing the hypothesised direction of effects). The strength of circadian/personality modifiers was further underlined here where, for all outcomes at T1 (except sleep length between successive afternoons, quick return and rest days), they were the only category to increase the predictive power of the equation. However, for both attitude items, work related modifiers in the final step further increased the power of the model. At T2, significant increases were seen with the addition of work related variables on physical health, and circadian/personality variables for psychological health and sleep. In comparison to the findings on the relative importance of individual blocks of modifiers, the trends seen here had widespread support for previous chapters.

In the previous chapter we questioned whether 5 weeks would be sufficient time for changes in the outcome variables and the interactions between outcomes and modifiers to manifest themselves. Comparisons of the two studies show that the factor structures derived on the basis of T1 responses held at T2 (with the exception of the perceived advantages of shiftwork) with a similar pattern of relationships between outcome variables also evident. For example, in both studies, T1 social and domestic interference correlated with T1 preference for daywork, whilst T2 social and domestic disruption correlated with T2 physical health. Moreover, in both studies psychological health and sleep and physical health correlated at both initial testing and follow-up. A preference for daywork over shifts was the outcome most consistently linked to sleep length.

In contrast, respondents in both studies showed a stronger preference for shiftwork over days and better physical health at T2 but a worsening of social and domestic problems, but differed on all other outcome measures. Workers in the previous study perceived fewer advantages of shiftwork at follow-up whilst here workers had a more favourable attitude. Moreover, whereas workers in the previous study reported more psychological health and sleep problems at follow up, in the present chapter this trend was reversed. Such results suggest that longer exposure to a shift benefits certain attitudes towards shifts, and enables better adjustment of psychological health and sleep quality. Social and domestic life and physical health, on the other hand, were affected to a similar degree in both studies and therefore, do not benefit from greater exposure. Given that these studies differed in terms of the shift systems involved, the types of industries used and the circumstances of the respondents (e.g., the high level of contractors in the previous study) it is difficult to directly compare the findings. Had an additional testing stage taken place after the first 5 weeks in the present study, the degree of adaptation could have been more directly compared. However, due to the constraints of testing in industrialised settings, discussed in greater depth below, this was not possible.

Although the present study allowed the opportunity of exploring whether the relationships uncovered in previous chapters existed in a longitudinal design, a number of weaknesses affected the interpretability of findings. Despite attempts to conduct the present study over a longer time period using a larger sample, the response rate at T2 was still small, again minimising the reliability of findings gained here. 147 respondents at T1 meant that for each independent variable used in the analysis n=8.65, whilst at T2 this was reduced further to just 2.65. According to the caveat mentioned earlier, both would fall below the threshold for gaining reliable results. R^2 values at T2 were also higher on the majority of outcome variables. The poor response rate overall also meant that the planned analysis of differences between groups had to be abandoned, again limiting comparisons with previous chapters. A large variation in experience of the present shift system was also evident amongst this sample (from 2 weeks to 37 years), a critical point given that this was a key feature of the present study. Thus the trends found may well have been due to the fact that adaptation was at a higher level in the sub-group of the cohort that had the longest experience. Further research should examine this possibility by comparing those with low and high experience. Given the small sample size in the present study this was not possible.

An original intention of the study had been to conduct 2 follow up surveys, one at 6 months and the second at 12 months in an attempt to track the progression of change and to examine whether critical points occurred for certain outcome measures. However, the problem of testing in an industrialised setting, outside of the tight constraints and controls of a laboratory is that the research can be affected by the needs of the company. This was the case here, where, due to production pressures at the site, in situ testing sessions conducted during work time could not be maintained, and the study essentially became a postal survey. Whilst it could be argued that this may have affected the results gained, the strong correlations between T1 and T2 outcome measures, where this change occurred, indicates that any effects were minimal.

Given that the strength of the relationship between on-shift alertness and measures of perceived risk were extolled throughout Chapters 7 and 8, it is unfortunate that this relationship was not pursued further here. Due to the nature of longitudinal designs this study was underway before previous studies had been conducted, even though it is the last to be reported. Throughout the thesis, surveys were conceptualised and developed through an iterative process between the researcher and the company, in an attempt to meet the interests of both. Measures of perceived risk were included in the questionnaires employed in Chapters 7 and 8 since both companies placed strong emphasis on maintaining and utilising accidents data to assess safety, and expressed a wish for related items to be included in the surveys. This was not the case in earlier studies where variables included were those addressed in the models of shiftwork tolerance, only one of which explicitly mentioned safety (Folkard, 1993).

The relationships between outcomes and modifiers gained here supported several lines of evidence from previous chapters. The study also provided some evidence that workers were adversely affected as their experience of the shift progressed, although this was only the case for selected outcome measures. Regardless of differences in the types of industries included or circumstances specific to studies (e.g., the ratio of contractors to those directly employed by the company, level of hierarchy tested), those working similar shift patterns showed similar patterns of findings. For example, in terms of the regression analysis most similarities occurred in line with Chapter 6, perhaps not surprising given that both groups were working discontinuous 8h rotating shifts. Moreover, similarities were also noted in line with those groups working rotating shifts with nights and/or permanent nightshifts in Chapter 7.

10

SUMMARY AND DISCUSSION

10.1. Introduction

The major aim of the thesis was to explore the models of shiftwork tolerance in terms of the purported relationships between outcomes and modifiers of the adaptation process. Of particular interest were individual differences as mediators of the relationship between shiftwork and well-being. Therefore, a secondary aim was to refine the individual difference measures used in such interactive pathways. In doing so the thesis explored the simple and complex interactions in a series of studies, covering a range of industries and shift systems.

10.2. Synopsis

Using a phenomenological approach, *Chapter 5* attempted to investigate the aetiology and management of problems through the eyes of shiftworkers themselves. Analysis of the perceived severity of problem areas supported the major domains identified in the literature, although the extent of the problems experienced varied as a function of the shift worked. Interview scripts were analysed for recurrent themes, many of which supported established trends in the literature, highlighting both outcomes and, to a much lesser extent, modifier variables. Interaction diagrams based on these findings were presented, showing some fit with a number of the models presented in Chapter 4, in addition to identifying new relationships. Further analysis showed there to be an overwhelming preference to continue working the same shift pattern, despite the problems identified.

Using themes derived from the previous chapter, *Chapter 6* involved a questionnaire study at the same site in order to gain information from a more structured and objective approach. Findings derived here supported those from the previous chapter, showing outcomes to be successfully and meaningfully grouped into major problem domains, with the existence of interactions between some outcome factors but not others. However, whilst the relative impact of each of the outcomes showed the same pattern across shift type, support for the previous chapter was lacking. It was suggested that differences in the collection of data may be an underlying reason for the divergence. Regression analysis showed the number and predictive validity of modifiers to vary according to the outcome variable under investigation, although similarities were most evident amongst those variables that correlated highly with one another. Of all modifier variables, SHLOC was most consistently linked with all shiftwork related problems.

Chapter 7 pursued a similar approach as above, but used a larger sample, across a variety of shift systems and companies. Although a much shorter questionnaire was employed, outcome variables could nevertheless be reduced into similar problem domains. A new factor labelled 'alertness and safety' was derived. Trends between outcomes were also supported. Extent of problems showed a strong shift-dependent effect, with those working rotating shifts without nights showing most impairments to physical health, social and domestic life, alertness and safety (M shift), least sleep (M shift) and the least favourable attitude towards shiftwork. In contrast, those working rotating shifts with nights showed least impairment. Stepwise regression supported this split, showing similar predictors for those involved in nights and a separate pattern for those not working nights. Despite this trend core modifiers (circadian type, commuting time and control) emerged for most, if not all, equations. Differences between shift systems combined under the umbrella groups were suggested as a possible mediating factor.

Since none of the models introduced in Chapter 4 incorporated tolerance of shifts over time, *Chapter 8* explored the effect of a short-term shift system on the relationships between outcomes and modifiers. Surveys were collected during the first 10 days of the shift and again 5 weeks later. Despite the small cohort, it proved possible to replicate several of the outcome factors, with all holding over time. The role of on-shift alertness was also explored in greater depth, and found to load highly on both psychological health and sleep and perceived risk. Analysis of outcome variables over the 5-week period revealed a worsening of all but the physical health, alertness and safety and preference for daywork measures, with the most substantial change being the length of sleep between successive rest days. In contrast, whilst stepwise regressions revealed predictive relationships for almost all outcomes, there was little support for these interactions over time. Overall, circadian modifiers showed the greatest predictive strength. As with previous studies, strongly correlated outcomes showed the most similarity in the predictors extracted. It was argued that the 5-week period over which the study was conducted may have been insufficient for the adverse effects of the shift system to be established.

Continuing this theme, *Chapter 9* examined the effect of a long-term shift system on tolerance, with workers completing two surveys, 12 months apart. Factor analysis and subsequent correlations between outcome variables revealed familiar trends, the majority of which held over time. However, analysis of impairment over time showed contrasting results to the previous chapter, with an improvement in all but social and domestic disruption, and sleep duration between successive afternoons, nights and rest days. Again, strongly correlated outcomes showed the most similarities in term of the predictors extracted, although few were consistent over time. Nevertheless, circadian/personality modifiers proved to be the most important category at both T1 and T2, regardless of the outcome measure involved. It was concluded that longer exposure to a shift benefits certain attitude measures and enables better adjustment of psychological health and sleep quality. Social and domestic life and physical health were affected to a similar degree in both studies and therefore, do not benefit from greater exposure.

10.3. Main Findings

Whilst the above sections give a synopsis of the intention and major findings for each chapter, the following section incorporates all studies together in order to present the main trends.

10.3.1. Advantages and Disadvantages of Shiftwork

Despite the negative bias toward the adverse consequences of abnormal work hours, there is evidence that some people enjoy working shifts (Harrington, 1978; Wedderburn, 1981; Olsson *et al.*, 1990) and that shiftwork offers a number of advantages (Taylor *et al.*, 1997). Indeed, these advantages can sometimes be so great as to outweigh any negative impact. In each of the survey studies, respondents were asked to report the three main advantages and disadvantages of their shift system. Responses were classified into major domains, with no attempt to match outcome variables under investigation. Analysis of these text responses identified a number of key points, that held true across shift type, although a distinction could be made between those working in production line situations and those involved in heavy maintenance, where safety was critical.

Amongst production line workers, social and leisure activities predominated, being reflected to a similar extent amongst both the reported advantages and disadvantages. However, whilst social and domestic effects were subsumed into a single factor throughout the research, they were perceived as being distinctly different in this context, suggesting that a distinction should be made between particular activities classified under this category. Indeed, the majority of responses under the advantages banner related to personal time, such as pursuing solitary activities or having time to relax, whereas disadvantages were group-based activities such as socialising with friends and pursuing league sports. Whilst this was true of all workers, characteristics of the work environment (e.g. less management) were also identified by those involved in nightwork. After social and leisure activities, fatigue and disruption to sleep were frequently mentioned as disadvantages, increasing at follow-up amongst those with longer exposure at the automobile plant (Chapter 9).

Of those involved in heavy industry, few mentioned rewards relating to sleep, or time spent on non-work activities, although both were reported as disadvantages, along with commuting time and concerns about safety at work. Indeed, for maintenance engineers, all respondents, regardless of shift type, perceived sleep disturbances to be the major disadvantage of their work pattern. Secondary disadvantages for this group were characteristics of the shift and work environment, whereas amongst those at the oil refinery, shift characteristics and work related themes, along with financial rewards, dominated the perceived advantages. Similar trends were also found at follow-up amongst the latter sample, although adaptation to the shift might explain the slight positive increase in sleep and social/leisure-related advantages.

Taken together, such trends challenge the assumption that, of all problems associated with shiftwork, disturbances of sleep are the most inevitable and far reaching (e.g. Foret *et al.*, 1980; Harrington, 1993), since evidence here suggests that this can vary with the type of industry, and the shifts worked within them. Moreover, whilst objectively measured sleep may suffer the most, this differs from the perception of those working shifts, where social and leisure time is deemed to be more important.

10.3.2. Associations between Outcomes

10.3.2.1. Psychological Health and Sleep Quality

In the reduction of outcome variables, a consistent finding was the relationship between indices of psychological health and sleep quality, suggesting that sleep disturbance amongst shiftworkers may be a psychological rather than a physiological phenomenon. That there may be a psychological element to sleep disruption has received little attention in the literature, yet was supported in the interviews (Chapter 5), with rotating shiftworkers reporting needing to wind down after a late shift or feeling anxious about sleeping through the alarm when working morning shifts. The most prominent remark was waking earlier than intended during periods of late shifts or days off. It is widely assumed that this reflects the partial adaptation of circadian rhythms, since such behaviour dissipates with increased exposure (although there was limited evidence of this in the longitudinal studies performed here). However, as with the so-called 'apprehension stress' seen among those performing night-watch duty (Torsvall *et al.*, 1987), whereby the mere anticipation of noise resulted in disturbed sleep, there is reason to believe that it may also be cognitively based. Indeed, although measures of sleep duration were treated separately in the analysis, correlations between outcome measures revealed weak associations between the psychological health and sleep factor and measures of sleep length, suggesting that sleep quality was not associated with the amount of sleep. This held across studies. Furthermore, consistently evident throughout were the lack of predictive relationships derived for sleep duration. Thus in Chapter 6 it was concluded that the poor performance of modifiers in the prediction of sleep length suggests that it may be more strongly associated with outcome, rather than modifier, variables, and thereby attenuated as a result of problems in associated areas.

10.3.2.2. Alertness and Safety

Not all derivatives of sleep were linked to mental well-being. Indeed, in the absence of psychological health measures, Chapter 7 revealed a strong relationship between alertness and measures of perceived risk. Such a link is not widely recognised in models of shiftwork tolerance, despite being corroborated throughout the research here (see associated papers by Folkard and Hill, 2000; 2001) and in the literature (Smith *et al.*, 1994, 1995; Åkerstedt, 1995; Folkard, 1997). For example, during the interviews, incidences of falling asleep at the wheel, and concerns about driving to and from work when tired, were recounted by a number of workers. As a result, the association was included in the interaction of problem domains based on the major themes derived at this stage. Such concerns were also evident in the reported disadvantages of shiftwork in Chapters 7, 8 and 9.

The inclusion of psychological health, on-shift alertness and risk measures in Chapter 8 allowed a further exploration of the relationship. Whilst alertness loaded on both the psychological health and sleep, and safety factor, it was the only item to reduce the reliability of the former, but contributed to the total reliability of the latter (although this was low). However, here a distinction between the two risk items was revealed, with 'the likelihood of making a minor mistake at work' loading highly alongside quality of sleep during rest days, cognitive fatigue, and measures of psychological health, and 'confidence in driving home from work' loading separately with quality of sleep during work days, physical fatigue and alertness, suggesting that future research should investigate the two as distinct dimensions. Despite this, to allow comparisons across studies, the factor structure combining the two was used in further analysis. This supported the findings from Chapter 7 showing a strong correlation between risk and physical health, psychological health and sleep, social and domestic interference and whether the advantages of shiftwork outweighed the disadvantages. In all instances, greater concerns over safety were related to greater impairment and a less positive attitude. Amongst maintenance engineers, alertness and risk was also strongly related to the length of sleep, a finding that questions those who advocate that decrements in human performance are the result of declining circadian rhythms rather than sleepiness (Mitler *et al.*, 1988; Lavie, 1991; Horne *et al.*, 1995).

10.3.2.3. Social and Domestic Life and Sleep Duration

Relationships between outcomes revealed a link between social and domestic disruption and sleep duration (Chapter 5), being highlighted for all shift types in the interaction figures. For mornings (Figure 5.1a) cumulative sleep deficit was related to napping, which in turn led to impairment of social and family life (Mott *et al.*, 1965). For afternoons (Figure 5.1b) problems in winding down from work meant that many stayed up after getting home. Late to bed resulted in a late rise-time the following day when friends and family were not accessible, and thus resulted in little social interaction. For night shifts (Figure 5.1c) sleeping during the day when most of society is active led to feelings of isolation. Whilst such a link was supported in each of the survey studies, other variables, such as attitudes towards shiftwork, and physical health, were also found to be related to the amount of sleep gained at different points of the shift cycle, although the pattern and strength of associations was not consistent.

10.3.2.4. Social and Domestic Life and Attitudes toward Shiftwork

Perhaps as an indication of 'commitment to shiftwork', whereby individuals committed to working abnormal hours show a tendency to arrange their lifestyles around their pattern of work (Folkard *et al.*, 1978; Minors and Waterhouse, 1983, Monk and Folkard, 1985; Brown, 1990; Härmä, 1993), social and domestic disruption and attitudes toward shiftwork were strongly and consistently linked, such that experiencing fewer adverse effects on non-work activities was associated with a more positive attitude and a preference for shiftwork over days. Indeed, in the majority of studies, the two produced the strongest correlation of all relationships. It was initially suggested (Chapter 6) that the interaction was aided by the fact that 2 of the 4 subscales within the 17-item Advantages of Shiftwork measure (Taylor *et al.*, 1997) related directly to social and family activities, similar to those used in Section 2 of the Social and Domestic Survey (Barton *et al.*, 1995). However, this did not explain its relationship with the second attitude item, a preference for daywork over shifts, suggesting an independent link between social life and shiftwork attitudes. Furthermore, equally strong relationships were found in Chapters 7, 8, and 9 with only single item measures, and in the absence of such specific inferences. Such a finding suggests that the two may be inherently linked, irrespective of specific types of advantages or social/domestic occasions. This was supported by the fact that similar modifiers predicted the extent of impairment in each of these areas.

These findings support a number of studies examining the association between attitudes and work/non-work conflict (Mott *et al.*, 1965; Jamal, 1981; Walker, 1985). Both Wedderburn (1978) and Bohle *et al.* (1998) posit that the effects of shiftwork on social life are the most frequently nominated reason for disliking shiftwork. Moreover, such findings are reminiscent of Zedeck *et al.* (1983) who found shiftwork satisfaction to be most highly correlated with a cluster of work/non-work variables including satisfaction with social and family activities, in addition to activities involving children and solitary hobbies. Such a relationship also supports those models which posit the importance of disturbances in sociotemporal patterns as a major mediating variable in measures of shiftwork tolerance (e.g., Åkerstedt *et al.*, 1976).

10.3.2.5. Comparison of Trends with Models of Shiftwork Tolerance

In terms of the models of shiftwork tolerance, few of these associations are recognised. For example, the strong relationship between psychological health and sleep led to the two measures being subsumed into a single factor and taken forward as a factor in further analysis. Bunnage (1984) includes both as consequent, but separate, variables of shiftwork tolerance and suggests that they are inter-related, such that those who experience problems in their sleep also experience problems with their psychological health. Knutsson *et al.* (1990) treat them as separate variables.

Given the strength of the relationship between alertness and perceived risk it is surprising that this association is not recognised in any of the models of shiftwork tolerance discussed in Chapter 4, especially since it was uncovered early on in the interviews, and is supported by a large body of literature on the association between sleepiness, fatigue and industrial accidents (e.g. Carter *et al.*, 1982; Folkard *et al.*, 2001). Indeed, according to Monk *et al.* (1996) accidents on the journey home represent the major risk of bodily harm in shiftworkers whose actual work may be inherently fairly safe. All models are based around the premise that shiftwork leads to illness and disease, rather than to accidents and risks to safety. Where 'risk' is mentioned, it relates only to smoking or dietary habits (Haider *et al.*, 1988; Knutsson *et al.*, 1990). The only exception to this rule is the conceptual model of Folkard (1993) who mentions safety, where, rather than being presented as a single variable, it is mentioned alongside physical health, a relationship supported here.

Although not covered in the above discussion, Chapter 6 (the only study to explicitly measure dietary habits and eating behaviour) revealed a strong correlation between psychological health and eating, such that those with greater psychological and health complaints also had poorer dietary habits. However, according to Knutsson *et al.* (1990) only social disruption leads to dietary change and therefore to disease.

In contrast, although the interactions between social and domestic disruption and sleep duration are addressed in several of the models, the extent of the relationship between the two varies. For example, Monk *et al.* (1988) posits a relationship between 'sleep' and 'social life', presenting the two as separate but interactive variables, whilst Smith *et al.* (1993) incorporate both 'disturbed sleep' and 'disturbed family and social life', presenting the two as separate domains that are not explicitly linked. Similarly Knutsson *et al.* (1990) mention social patterns and sleep/wake disturbances but present the two as separate variables that do not interact with each other. Furthermore, despite the strong and consistent relationship between social and domestic disruption and attitudes towards shiftwork, only two models incorporate similar elements. Haider *et al.* (1988) propose that 'attitudes' and 'family situation' interact with each other via multi-directional pathways, whilst Bunnage (1984) suggests that 'family and social life' is amongst other consequent variables affecting a worker's 'subjective experience and attitudes'.

10.3.3. Associations between Modifiers

Modifier variables were categorised according to their definitions (i.e., extroversion-introversion as a dimension of personality, and morningness-eveningness as a circadian characteristic), and used sequentially in the order: demographic, circadian/personality, work-related. The rationale behind the order of entry in regression analysis stemmed from evidence showing a relationship between demographic variables, such as age, with circadian/personality variables such as morningness (Fröberg, 1977; Kerkhof, 1985b; Meccaci *et al.*, 1986). Together demographic and circadian/personality variables can mediate the impact of work related dimensions (Spector, 1982), such as job satisfaction and job demand, that in turn can affect the ability to tolerate shiftwork (e.g. SHLOC: Smith *et al.*, 1995). Such relationships were not suggested by the models of shiftwork tolerance.

No attempt was made to associate modifiers across categories (but instead were divided into conceptually different categories), although in the case of work-related variables, which included a number of single item measures and showed a number of inter-item correlations, an attempt was made to reduce their total number. This was based on the predicted relationships between items as proposed by the JD-C (Karasek, 1979) and ER-I models (Siegrist *et al.*, 1990), and fuelled by debate on the direction and strength of interactions between job and life satisfaction (Judge *et al.*, 1994). Analysis revealed that across studies, the two control measures ('control over the specific shifts worked' and 'control over the specific start and finish times of the shifts worked') correlated positively and highly, showing good internal consistency (ranging from .65 to .83). However, interestingly, 'perceived control over job pacing', thought to be a related item, failed to correlate highly. Weakly related to job freedom and general job satisfaction in Chapter 6, in Chapters 8 and 9 no such interaction was found. Finally, workload, job demand and decision latitude loaded positively on a single factor in Chapter 6, and were subsumed into a single dimension labelled "Job Demand", whilst in later studies, where only workload was included, this again loaded on a separate factor.

According to the JD-C model, control can be conceptualised as decision latitude. The fact that control items and decision latitude loaded on separate factors failed to support such a prediction, although it should be borne in mind that the control items used here were specific to shiftwork and not work in general. Moreover, according to this model, high strain jobs are those characterised by low control and high demands, and so an inverse relationship would be predicted between these items. Although this was found to be the case, the correlation was weak and failed to achieve significance. Despite this, one relationship was supported. According to the ER-I model, high workload should be positively related to low control. Analysis of this interaction showed a significant negative correlation, supporting the hypothesised direction of effects.

10.3.4. Predictive Relationships by Outcome

Attitudes towards shiftwork were consistently predicted by work-related modifiers in stepwise analysis (oil refinery workers in Chapter 8 being the only exception). However, not all modifiers within this category were equally important. In those surveys employing a 'general job satisfaction' measure this showed the greatest predictive power, whereas in its absence the global 'control' measure was most consistently extracted (as evident in Chapter 7). The strength of variables within this category was further underlined by the finding that, where more than one predictor entered the equation, work dimensions were consistently strongest overall. Such a relationship is mentioned in the models of both Bunnage and Haider *et al.* In the former, work characteristics are purported as both consequent ('work life') and modifier ('work situation' and 'work sector') variables of the adaptation process, although work life is directly linked to 'subjective experience and attitudes'. In the latter model, attitudes are mediated by 'work situation' and in turn affect 'job conflicts'.

Given the strong correlation between attitudes and social and domestic interference throughout all 4 chapters, it was not surprising that work related elements also emerged as strong variables in the prediction of the latter, although in each case circadian/personality characteristics had more predictive power. Again, both the models of Bunnage and Haider *et al.* mention this interaction, suggesting that social and domestic life leads to shiftwork attitudes.

Less consistent was the predictive power of groups of modifiers when entered in individual blocks, suggesting that certain modifiers were stronger than others despite being contained within the same category, and thus lose some of their strength when grouped with similar, but weaker, variables. In terms of the perceived advantages, work related modifiers accounted for the highest proportion of variance on only two occasions, with either circadian/personality or demographic variables being the strongest on others. Three different trends were seen amongst maintenance engineers, and appeared to follow no pattern. Circadian modifiers were by far the strongest category for the preferences for daywork and social and domestic measures, (although again, Chapter 7 was an exception to this rule, with demographic variables predominating across shifts). This theme continued when the sets of modifiers were entered sequentially. In most cases the addition of both circadian and work related modifiers resulted in a significant increase in the power of the model, suggesting that both contributed to the prediction of outcomes over and above any covariation with the modifiers entered before them. Few increases were seen for social and domestic disruption although, where these did exist, they resulted from the addition of circadian/personality modifiers only.

Similarly, the association between health outcomes was reflected in similar predictors, where, for both, a strong circadian element was evident. In terms of psychological health and sleep, 'languidity' was extracted in all 3 chapters in which it appeared, being the most important modifier amongst shiftworkers at the oil refinery, and second most important amongst those at the computer peripherals and automobile plants. The strength of circadian type was also highlighted with the extraction of 'flexibility' in Chapters 7 and 8 (T1 responses only). Although the regression equations derived for physical health were also characterised by a prominent circadian component, a less consistent pattern was found. Circadian type was extracted in most instances, 'languidity' in Chapters 6 and 9, and 'flexibility' in Chapters 8 and 9 (T1 only). However, in Chapter 8, circadian phase proved to be the common variable, with 'morningness' being the most important predictor amongst groups involved in nightwork. Despite the strength of circadian characteristics, work related variables were also represented in a number of cases. The pattern of predictors here was less consistent, with 'job demand' extracted in Chapter 6, 'control' in Chapters 7 and 8 (T2 only), and 'workload' in Chapter 9 (T2 only).

Hierarchical analysis supported these trends, with circadian/personality components accounting for the highest proportion of variance in both health measures when entered individually. When entered sequentially, this category showed little attenuation by either demographic or work-related variables in the prediction of psychological health, however, for physical health, trends varied across studies. For example, in Chapter 6 a significant increase was evident with the addition of circadian/personality variables only, whilst both circadian/personality and work-related variables produced an increase for Chapter 7 (a pattern consistent across all 4 shift types). In Chapter 8 neither resulted in a significant increase, whilst in Chapter 9, circadian/personality modifiers resulted in a significant increase at T1 and work-related variables at T2.

In terms of the alertness and safety factor, few similarities were found, although overall circadian/personality, and to a lesser extent, work variables were the strongest predictors. As with the previous outcomes, hierarchical analysis showed little consistency between studies. Despite the strong circadian component, demographic variables explained the greatest proportion of variance in alertness and safety during the morning shift when tested individually, whilst for afternoon and night shift measures, the circadian/personality category was stronger. When entered sequentially, a mixture of trends were found for the morning shift, whereas for afternoon and night shifts, both circadian/personality and work-related modifiers increased the predictive power of the equation.

Finally, in contrast to those patterns mentioned above, but perhaps indicative of the lack of associations with other outcome variables, demographic variables were the strongest predictors of sleep duration at different points of the shift cycle. Indeed, of all outcomes, this was the only one to extract 'age', 'number of children', 'marital status' and 'gender' in the final equations, although they were rarely the most important variables overall. Although differences between the surveys used made it difficult to directly compare trends across studies, where questions relating to sleep length were comparable, similarities in the predictive relationships also occurred. 'Perceived sleep need' emerged as a common predictor for the length of sleep before the first early shift (Chapters 6 and 8), whilst 'number of children' predicted sleep length following the final shift of the cycle (true of afternoon shifts only in Chapter 6). Sleep length between successive night shifts was the only variable to show a common trend, with 'flexibility' extracted in the 3 studies that specifically questioned this information. Circadian phase was also extracted for Chapters 7, 8 and 9.

The review of the literature showed a strong circadian component in all domains affected by shiftwork, from the 'commonest' disturbances of sleep, to psychological health and digestive function. For example, rigidity and languidity were associated with greater impairments in all outcomes investigated, covering attitudes (Iskra-Golec, 1993), psychological and physical health (Folkard *et al.*, 1980; Wynne *et al.*, 1986; Silvero *et al.*, 1997; Ognianova *et al.*, 1998), alertness and safety (Folkard *et al.*, 1979) and sleep duration, and was true across all 4 studies. This supports Folkard *et al.* (1979) who argued that better adjustment was shown by those who were flexible in their sleeping habits and vigorous in their ability to overcome drowsiness. Circadian phase was extracted to a much lesser extent, although where this did occur, it nevertheless supported established trends within the shiftwork literature (E-types having poorer dietary habits (Fröberg, 1981) for example). Shift dependent effects were also evident. E-types had more fears about safety on the early shifts and M-types more fears on the afternoon and night shifts. Moreover, M-types gained more sleep during early shifts, but less during periods of night shifts (Colquhoun, 1960; Kerkhof, 1985; Adan, 1994; Natale *et al.*, 1996). Such findings support the notion that M-types prefer to concentrate their activity during the morning whilst E-types are better able to function during the afternoon and early evening.

In terms of personality, the purported relationships between introversion and psychological health were supported in Chapter 6 and 9 (Singer *et al.*, 1990), whereas support for the LOC measure was much stronger. Here internality was associated with more favourable attitudes, fewer health complaints, less social and domestic disruption and better dietary habits (Smith *et al.*, 1995). Throughout the studies, sleep was consistently predicted by demographic variables, comparatively moreso than the remaining outcomes. For example, older workers (Haimov *et al.*, 1997; Miles *et al.*, 1980), those with more children (Andersen *et al.*, 1987; Costa *et al.*, 1991; Lee, 1992), having a partner (Loudon *et al.*, 1997), and a longer commuting time (Folkard *et al.*, 1993) gained less sleep. Interestingly, in contrast to the purported relationship between sleep length and gender, where this was extracted as a predictor, females were found to gain more sleep than their male counterparts (Gadbois, 1981; Oginska *et al.*, 1993). Finally, as supported by the likes of Cooper *et al.* (1990), Frankenhauser (1975) and Repetti (1993b) work-related variables were extracted as significant predictors of all outcomes under investigation, where less perceived control, greater workload, less job satisfaction, and being employed on a temporary contract were associated with less favourable attitudes and greater impairments to health and satisfaction with social and domestic life.

The strength of circadian variables in predicting problems in the samples used here is perhaps not surprising and supports those models that posit circadian rhythms as the key to shiftwork tolerance (Åkerstedt *et al.*, 1976; Rutenfranz *et al.*, 1981). What the present study has achieved, however, is a refinement of this view by showing that not all circadian components are equally important, but that it is primarily those that describe an individual's ability to sleep at flexible times or to overcome drowsiness that constitute the strongest predictors overall. Furthermore, the findings suggest that shiftwork tolerance is not exclusively a matter of circadian adjustment since the pattern of predictors depended on the outcome variable under investigation, and was influenced in some circumstances by the strength of relationships between items. Thus, whilst circadian variables consistently accounted for the highest proportion of variance in the health outcomes, regardless of the acute contribution of other variables such as age and personality, the related domains of social and domestic disruption and attitudes toward shiftwork were best predicted by work-related variables, the strongest of which was 'satisfaction and contentment with the job'. Meanwhile, sleep duration was best, and almost exclusively, predicted by demographic modifiers. Thus, unlike the majority of the models that present modifiers as 'sets' of variables, such findings support the approach of more recent models that concentrate on discovering single measures with the greatest unique contribution (Smith *et al.*, 1999).

Thus, whilst most of the models incorporate a number of the variables used here and hypothesise a number of the relationships uncovered, they fail to embody the complex aetiology underlying many of the problem domains linked to shiftwork tolerance. Furthermore, rather than being a linear relationship, the trends found here suggested that the interactions between outcomes and modifiers were multi-directional in that both were influential in affecting the extent of related problem domains. So, for example, circadian modifiers may be the best predictors of psychological health and sleep, but it is this outcome that affects the length of sleep, over and above any individual characteristics. Although this relationship was not specifically mentioned, several of the models of shiftwork tolerance treat changes in sociotemporal patterns as an additional modifier variable. Thus, as discussed below, although the findings here supported several elements of the models discussed in Chapter 4, the underlying theme is one of multi-directional pathways consequent upon not just the shiftworker and the individual qualities (modifiers) they bring to the situation, but also the type of shift worked, the type of industry under investigation, and the length of exposure.

10.3.5. Effect of Exposure

Evidence from the literature suggests that adaptation to a shift increases over time such that greater exposure results in better adaptation and fewer problems. However, in terms of the models of shiftwork tolerance, only Haider *et al.* (1988) make a distinction between experienced and inexperienced workers. Chapters 7 and 8 adopted a longitudinal approach in an attempt to examine whether the relationships between outcomes and modifiers were moderated over time. In these studies, adaptation over 5 weeks and 12 months was examined.

Analysis of outcome variables showed a beneficial effect of experience, with greater exposure associated with an improvement in the perceived advantages of shiftwork, preference for shiftwork, psychological health and sleep, physical health and sleep between morning shifts and a quick return. Social and domestic disruption and sleep duration between successive afternoon, nights and rest days showed a worsening over time. In contrast, in the short-term study improvements were found for the preference for shiftwork measure, physical health, alertness and safety and sleep between successive work days at follow-up. Perceived advantages, social and domestic life, psychological health and sleep were found to be worse. No comparison between T1 and T2 was found to be significantly different on any of the outcome variables used in either study, although a number of component items were found to be so.

In terms of the predictive relationships, similarities between baseline and follow-up were few, although a number of trends were noted. This supports the findings of exposure studies reported in the literature showing relationships between variables to alter with time, thereby advocating that interactions are an evolving process. The link between psychological health and sleep and 'languidity' held over both the short and the long-term, being a common predictor at both T1 and T2 across studies. Other similarities emerged in Chapter 9, where 'job satisfaction' consistently predicted attitudes toward shiftwork, being the only variable to enter the solution at both time points. The only other outcome to show such a pattern was the length of sleep between successive morning shifts, where 'flexibility' was extracted at both T1 and T2. Whether the lack of consistency between studies was due to the length of exposure, the so-called healthy shiftworker effect, the types of shifts involved (those in Chapter 8 worked permanent days, whereas those in Chapter 9 worked rotating shifts with nights), or to different types of industry, is difficult to establish.

Furthermore, many of the circadian and personality scales were not included in the follow-up questionnaires since the test-retest reliabilities have been widely published. By not doing so it was impossible to establish whether the change in outcome variables occurred in the absence of a change in these individual characteristics (and therefore were due to exposure to the shift), or whether adaptation was also evident in the modifier variables (and therefore possibly due to this change rather than the length of exposure). Thus cause and effect could not be concluded. An important point to bear in mind when interpreting these findings, however, is that exposure studies can be affected by the healthy shiftworker effect, whereby those who remain working shifts for the longest times are those who are able to tolerate their pattern of work. In this sense it could be argued that those surveyed at T2 in Chapter 9, 12 months after the first data collection, were those who were either better suited, more robust, or simply more determined to adapt, and therefore would be expected to suffer fewer negative effects as a consequence. This caveat could also be levelled at all studies conducted here, since all used existing shiftworkers rather than those with no previous experience. Research has shown that modifier variables such as those used here may be affected by working shifts, and therefore may partially reflect responses to shiftwork rather than true independent predictors.

10.3.6. Effect of Shift Type

It is well established that in industrialised settings especially, both the work environment and nature of the job can change according to the type of shift worked (Colquhoun, 1976; Harrington, 1978; Carter *et al.*, 1982; Knauth, 1983; de Vries *et al.*, 1987; Folkard, 1997; MacDonald *et al.*, 1997). During night shifts management levels are usually low, with few, if any, office staff and only a skeleton crew of workers. This was particularly true of the computer peripherals plant, where the night shift was characterised by a more relaxed atmosphere, with music playing, and a smaller team of individuals, leading to a greater sense of camaraderie. However, for the maintenance engineers, the night shift was characterised by the highest pressure and the need for quick turn-around times, often resulting in unscheduled overtime.

An original aim of each study was to examine the predictive relationships between shift types, since all companies used a variety of work patterns. However, due to poor response rates in 3 of the 4 studies, this was only achieved in Chapter 7. Shift dependent trends found here suggested that the presence of nightwork was the common link in determining the relationships between outcomes and modifiers. Rather than seeing a split between rotating and permanent shifts, a more reliable pattern of results emerged between those involved in nightwork (rotating with nights and permanent nights) and those not (rotating without nights and permanent mornings). Although a number of differences were found between rotating and permanent shifts, these were much weaker and less consistent, often depending on the night/no-night distinction. Whilst this challenges the traditional rotating versus permanent divide, such a finding supports more recent models of shiftwork tolerance that advocate a mediating impact of the type of shift worked (Folkard *et al.*, 1993, Smith *et al.*, 1999).

In terms of the impact of shift type on shiftwork tolerance, the distinction between nightwork and non-nightwork was more prominent than the rotating and permanent dichotomy. Rotating shifts were associated with less impairment to a number of outcomes, although in the majority of cases, those working nights as part of their system fared worse than rotating groups without nightwork or either of the permanent systems, showing less favourable attitudes, and greater impairments to physical health, social and domestic life, and alertness and safety. Permanent groups gained more sleep between work days, whilst sleep duration between successive rest days was longest in nightworkers and shortest among those employed on mornings. In the night versus non-night distinction, amongst rotating groups, those involved in nightwork had better attitudes, and least problems with physical health, social and domestic life, and sleep length during work days, but had impaired alertness and safety during the night shift. Amongst permanent workers, those working nights had less favourable attitudes and reported more physical health complaints, although they gained more sleep during days off. Thus, although nightwork had a more favourable effect on those involved in rotating shifts, this was not fully supported in the permanent groups.

In Chapter 7 it was suggested that the shift dependent effects were due to the presence of nightwork, given that nightwork poses the most upheaval to man's natural diurnal rhythms. In support, stepwise analysis revealed a strong circadian element to the prediction of outcome variables for those working nights only, with circadian type being the most important predictor for attitudes towards shiftwork, physical health, and social and domestic interference. Both circadian type and phase were extracted as important predictors of alertness and safety during the night shift, and sleep length between successive nights (although this was true of rotating groups only). Interestingly when categories of modifiers were entered in individual blocks, this relationship only held for physical health, and alertness and safety.

Analysis of similar shift types between studies showed a number of familiar trends. Similar predictors emerged in stepwise models for those working rotating shifts without nights (Chapters 6 and 7), and those with (Chapters 7 and 9), although as with the results above, patterns of findings were weaker in the hierarchical approach. In the latter, it could be argued that the two were not strictly comparable given that maintenance engineers worked only mornings and nights as part of the system, whilst automobile plant workers were involved in mornings, afternoons and nights. The comparison between permanent mornings/days groups (Chapters 7 and 8) yielded the least similarities. In the stepwise approach, attitudes toward shiftwork and physical health were best predicted by work-related variables, whilst psychological health and sleep showed a strong circadian component, the most important variable being 'languidity'. Meanwhile for sleep duration between successive rest days, 'age' was consistently extracted. Hierarchical equations showed wide variation.

10.3.7. Was the Relationship Attenuated by Type of Industry?

Differences in the types of industries studied may also have mediated the trends, perhaps explaining the predominance of work-related predictors for a number of outcomes across studies. Indeed, more recent models of shiftwork tolerance, such as that proposed by Smith *et al.* (1999), have begun to incorporate the type of industry as an important factor in the relationships between modifiers and outcomes, showing interactions to differ between nurses and industrial workers. Of the earlier models, Bunnage (1984) was the only one to mention "work sector" as an intervening variable.

At the computer peripherals plant, workers were involved in continuous assembly operations, but were able to pace their own work, with the majority of personnel seated throughout their shift. In contrast, those working in the automobile plant were involved in a similar process, but complained of a dirty environment and work that was physically hard, and were required to stand throughout their shift. Maintenance engineers worked in a safety-critical environment, and had long periods of down-time punctuated by periods of high demand. Their work was also characterised by overtime and limited breaks. Much of this work was performed outside, and reportedly physically difficult. Whilst those at the oil refinery also worked outside and had to be wary of the safety of themselves and others, this work was characterised by time pressures, and described as both mentally and physically demanding. Thus, such unique conditions should be borne in mind when attempting to compare findings across studies, since the term *shiftwork* can disguise subtle differences in the level of job demand, workload and, perceived control, that can depend on the type of industry.

10.4. Methodological Limitations

Throughout the thesis, attention was drawn to the methodological limitations of each study, discussing the ways in which these undermined both the generalisability and interpretability of findings and their comparison across studies. Perhaps one of the most obvious of these were the differences between cohorts, in terms of both the types of industries and shift systems under investigation but also in the those characteristics known to mediate a worker's response to shiftwork. For example, workers at the computer peripherals plant were younger, had less work experience, and, due to the high percentage of contract personnel employed at the site, had much less experience of the present shift than workers sampled in the remaining chapters. This cohort was also characterised by the highest ratio of females to males. Since each of these factors have been shown to affect the experience of shiftwork-related problems, either in isolation or combination, such differences should be born in mind when comparing and interpreting the findings across studies.

Due to the nature of the research, it was not possible to employ the same questionnaire throughout studies (the reasons for this are discussed in the following section), meaning that the importance of certain variables, such as alertness and safety, could not be pursued throughout. In some cases, reduced or abridged versions of scales were employed, whilst in others, response scales were not consistent. For example, Chapter 7 employcd 9-point Likert scales, whilst the remaining chapters used 4-point scales. That such details can have implications for the findings was addressed by Pitsopoulos and Greenwood (2002) who compared the frequency of gastrointestinal and cardiovascular symptoms made on the SSI 4-point scale ('almost never' to 'almost always') with an alternative 9-point scale where options were expressed in absolute values (e.g. 'once a week'). Results from non-shiftworkers showed correlations between formats to be low, with substantial variability in the interpretation of the response categories. Might this also be the case for other items here where different response options were employed?

The present thesis piloted a new circadian dimension in the form of the Time Awareness Questionnaire. In comparison to other circadian modifiers used in the analysis, its power as a predictor of shiftwork tolerance was lacking (with only the 'morningness' and 'strength of preferences' subscales being extracted in stepwise regression analyses). The scale itself also received criticisms as to its overall length, and the wording of both the instructions and response options given. Factor analysis of the combined scores from each stage of the research addressed the first of these, and resulted in a reduced 29-item version, retaining the original 3 factor structure, each showing good internal consistency (ranging from α.7055-.8915), both in the combined analysis and in each of the separate studies. In terms of the wording, many found the instruction "In comparison to most people…" difficult to comprehend, commenting that they were unaware of other people's preferences, and therefore could not easily comprehend the response options given. Interestingly, similar remarks were made in line with the perceived workload scale where a similar instruction was employed. It is suggested that future research using the scale should remove the offending instruction and change the response options accordingly to read "very early", through to "very late" for questions relating to the morningness/eveningness dimension, "very strong" through to "very weak" for the strength of early/late preferences dimension, and "very easy" through to "very difficult" for the time awareness dimension. Future research, correlating the two formats with one another, is needed to evaluate whether this affects the responses given. Unfortunately it was beyond the scope of the present thesis to address this issue.

On a similar note, in certain studies the formatting and wording of items within the questionnaires may have affected the motivation of workers, and therefore had an impact on the overall response rates. For example, rotating shiftworkers mentioned that problems varied according to each type of shift within a single work pattern. Thus, early, late, and night shifts were qualitatively different from one another despite being subsumed under one heading. Thus a number of respondents remarked that they were unable to complete certain questions that asked about their 'shift system', commenting that they would have preferred separate questions for each. Such a finding suggests that the remarks made concerning the ranking sheets used during the interviews stage of the research, whereby those working rotating shifts were given separate sheets for each shift type worked, may be less problematic than originally concluded. Taking this type of care in the design of questionnaires will only serve to enhance workers' motivation to take part in research, benefiting both the generalisation of conclusions and the applicability of recommendations made as a result. Indeed, in an evaluation of questions and responses employed in occupational questionnaires, Stewart, Rice, Beatty, Wilson, Stewart and Blair (2002) asked respondents to identify any difficulties they experienced in answering the questions posed to them. Certain questions were found to reduce the effectiveness of the survey due to unclear terms, questions open to multiple interpretations, difficult computational requirements (e.g. asking for averages of highly variable tasks), ineffective transitions between topics, and overlapping response categories, many of which have been mentioned throughout the studies reported here. However, a further issue that should be addressed is whether responses were affected by the notion that the findings would be fed back to managers and supervisors. Although all those taking part were assured that their answers would be confidential and that no individual would be personally identifiable, there is no guarantee that the results represented the true picture, since there is a risk that respondents were recording what they thought their managers and supervisors wanted to hear.

The poor response rates may also be explained by those workers who commented that shiftwork interfered with their lives both in and out of work and, thus, were reticent to use their personal time to complete work-related surveys. Such comments were most prominent in Chapter 9, which had to resort to a postal method. Whilst a number of surveys were successfully completed and returned, several were returned uncompleted, accompanied by statements such as *"Shiftwork affects my home life enough already and I'm not prepared to let it take any more of my time"*. A similarly poor response was gained from those who completed surveys during work hours, with the general feeling being that doing so would not result in change. Thus, whilst incentives were offered in 2 of the studies, these were not deemed sufficient compensation. Although it could be argued that better incentives should be offered in an attempt to increase the numbers of those willing to participate, this runs the risk of surveys being completed for this reason only, with individuals giving little regard to the truth or accuracy of their responses. A better strategy, therefore, would be to integrate such research into the requirements of the job, to make it part of the normal routine and to emphasise to workers that their concerns and feedback are being recognised. Of course the success of this depends on the companies' motivation to use the findings in a proactive way, such as in the development of principles for the selection of workers into shifts, compensation for shiftwork, and the design of shiftwork schedules that address the concerns of the workforce.

10.4.1. Problems of Conducting Research in Industrialised Settings

Of particular importance here were the problems encountered in conducting research in industrialised settings. Throughout each stage of the research, companies, as well as individual workers, lost interest, and began to feed their time and resources into other areas that gave them almost instant results. It is undeniable that making psychology attractive to business is difficult even when the aim is to improve the processes within them and the health of the company as a whole. However, whilst this may be difficult, it has major implications if the findings from research such as that discussed here is to be of any practical use. This is even more important in the field of shiftwork for the use of guidelines derived from scientific research to aid the adaptation of workers. Companies thrive on success and so hold-ups and lack of significant findings can give the wrong impression, making them less likely to initiate programmes to aid those working irregular hours. Thus, as well as conducting studies into the effects of shiftwork, future research needs also to study how best to translate the results to those in the practical setting.

In order to strike a balance between good research and the needs of the company, researchers can be swayed in what they are able to do, as was the case here with the length and type of items used in the questionnaires. However, some problems were unavoidable from both the company's and the researcher's part. In Chapter 6, for example, restructuring of the company meant that the original cohort of over 200 was reduced to only 30, with all production ceased. Thus the original aim of designing and testing a Shiftwork Awareness Programme, based on the findings from the interviews and survey study performed at the same site, could not be pursued. In Chapter 9, the completion of surveys during company time was halted due to a rise in production. Consequently a drop in response rates were seen with the implementation of a postal survey. Maintaining cohort numbers was also difficult in the longitudinal studies given the natural attrition over time from retirement, illness, holidays and waning motivation.

10.5. Implications and Practical Applications

That shiftwork can have adverse effects on workers is now widely recognised with both legislation and industry taking an active role in protecting the worker from harm. Indeed, despite de-motivation of both managers and personnel in several of the studies, all stages of the research contributed to a wider company approach to the management of shiftwork problems. Chapters 5 and 6 were undertaken in the development of a Wellness Programme, with the results of the interviews and survey intended for use as the basis for a shiftwork intervention programme, aimed at educating workers on how best to cope with the problems experienced as a result of their work pattern. Although this was designed, changes at the site meant that it could not be piloted. The primary concern in Chapter 7 was to establish the range of work schedules in use for the engineering industry, and was requested by the government agency responsible for the regulation of the specific industry examined here. The work discussed in Chapter 8 was requested by the Occupational Health team who wished to examine the effects of short-term changes in shift systems through indicators of stress. More specifically the company were interested in evaluating whether the types of shifts used during shutdown periods were stressful to the point of harming workers, and therefore compromised their safety and that of their colleagues. The results were used as a guide in the design of work patterns during these times. Similarly, Chapter 9 was undertaken in response to the company's wish to examine whether shiftwork-related problems differed across shift systems in addition to the plant as a whole, with the resulting trends being employed as a guide for the utilisation of various types of working patterns.

10.5.1. Why is Shiftwork Research Important?

Over a hundred years ago, individuals were put to work in asbestos or coal mines, with little thought given to the potential for harm. With hindsight, we now know the true extent of these consequences, with horrendous respiratory disorders such as asbestosis and lung cancer. Likewise, shiftwork is not a new phenomenon, and has been discussed from a number of historical perspectives (Scherrer, 1981). Although from the industrial revolution it was deemed innocuous for individuals to be involved in hours of work outside the 9-5 regime, the wealth of evidence in the shiftwork literature suggests that shiftwork is not as innocuous as it first seemed, with almost daily news articles reporting compensation claims and a never-ending stream of articles being added to the already extensive literature. Even though we are today more aware of the adverse effects of shiftwork, there is little legislative power to prevent businesses from employing individuals on round-the-clock schedules, although the European Working Time Directive has gone some way toward providing guidelines governing the design of specific systems. Indeed we are guilty ourselves of inciting the potential for harm by putting pressure on companies to provide a 24h service that we have now come to depend on. Indeed, shiftwork is seen to help both society (with round-the-clock hours giving rise to lower unemployment), and the economy (by increasing productivity). Thus, it seems that, for the time being, shiftwork is here to stay, and will undoubtedly continue to rise unabated in the light of current trends in economic globalisation and climate.

Whilst it could be argued that the findings from research such as that detailed here could be used to develop criteria for the selection of those most suited to different types of shift systems, as suggested at the end of Chapters 2 and 3, such practices are fraught with complications. There is a social barrier about being prejudicial in allowing some to work shifts whilst excluding others from doing so, since this denies individuals the opportunity for higher pay or more flexible childcare arrangements. Such arguments are evident in the current controversy over legislation preventing women from nightwork in a number of countries.

Given that people are generally aware of their own strengths and weaknesses, some may argue that individual choice is an effective method of self-selection into shiftwork. However, this is not a foolproof measure for ensuring that employees are working the best system for them. As we know from the shiftwork literature, people will continue to work abnormal hours, even though they acknowledge that they may be suffering as a result, because the rewards are greater (Barton *et al.*, 1993). This was also evident in Chapter 5 where there was an overwhelming preference to continue working the current shift pattern, despite the vast majority of interviewees identifying problems as a result of working shifts. Instead, selection should be based on established measures of risk and used objectively. However, even if this is achieved, there is no guarantee that it will be deemed acceptable by the likes of trade unions and proponents of the movement towards equal opportunities. In the words of Monk *et al.* (1996) "it is easier in shiftwork to outline the *problems* than to put forward *solutions*" (pp. 21).

10.6. Directions for Future Research

In terms of modifier variables, it was beyond the scope of the present thesis to examine all differences between individuals that have been linked to shiftwork tolerance. Instead, the studies encompassed here focussed on those that have received the most attention, in an attempt to refine existing knowledge on the way in which they interact with each other, and independently, to determine shiftwork outcomes. However, the way in which these were categorised was arbitrary, with no attempt being made to compile factors or groups of related variables. Thus, for example, although LOC was categorised as a personality attribute and classed as such throughout the analysis, central to its definition is the element of personal control. Indeed, evidence suggests that internality is associated with perceived control of work hours (Spector, 1982; Smith *et al.*, 1995). Analysis may have revealed an affinity with the work-related control items, thereby questioning its classification. Moreover, although circadian and personality variables were grouped under the same heading, given the strong correlations between the two (e.g. circadian phase and extroversion), and used as a single category in hierarchical analysis, stepwise analysis suggested that circadian characteristics were the stronger of the two.

Having established the existence of certain associations, future research must now examine the complex relationships revealed in the present data and explore their causal pathways. Is it the case for example, that in the association between social and domestic life and sleep, sleeping patterns specific to certain types of shifts interfere with a workers' social and domestic life (e.g. workers on an early shift have to leave social events early in order to get an early night), or that the distribution of leisure time associated with the shift affects the timing and amount of sleep possible (e.g. having to use recovery time to attend appointments or to complete chores)? Likewise, in explaining the association between attitudes and social and domestic disruption, is it the case that a worker involved in league sport prefers daywork to shiftwork because it allows them to attend practise sessions at set times on a regular basis, or is it that a preference for shiftwork over days reflects an underlying attitude and commitment to shiftwork, where workers are willing to organise their non-work life around their rest periods? Understanding co-morbidity between shiftwork problems may aid the development of more effective shiftwork programmes since the relationship between variables is as important as the individual components in targeting interventions. Thus in the same way that more recent multi-trait studies of shiftwork tolerance are beginning to evaluate intervening variables in relation to each other rather than in isolation, positing that it is the interaction between variables that may hold the key to their value as predictors, such an approach is also a worthwhile paradigm in the evaluation of outcomes of shiftwork tolerance.

Hand-in-hand with the argument for a multifactorial approach is the suggestion that we must learn to walk before we can run, as suggested by the likes of Smith *et al.* (1999) whose model of shiftwork tolerance represented a mid range approach, which attempted to refine earlier models by concentrating on specific individual and situational characteristics. In other words, it may be better to examine single outcomes and gain a greater depth of knowledge in fewer areas before attempting to understand the interactions between them. Indeed, taking a simpler approach may also aid response rates since the complexity and length of the questionnaires used was a prominent reason as to why workers were unwilling to complete them.

In addition to gaining a better understanding of existing modifiers there is also a great need to identify new and as yet untested variables or approaches. Tepas, Walsh and Howarth (2000) for example, suggest that the distinction between inter-individual differences (referring to differences between or among individuals) and intra-individual differences (referring to differences in shift usability within an individual at different points *in* time *or* situation) may be the way forward. Generally, modifiers used in research to date have accounted for relatively low proportions of variance in shiftwork tolerance. In the studies conducted in the present thesis, the percentage of variance explained ranged widely, although in the majority of cases, the small cohort size may have inflated the estimates.

In an attempt to introduce a new modifier to the area, the present thesis piloted the Time Awareness Questionnaire, divided into 3 subscales (morningness, strength of early late preferences and time awareness) which together allowed an analysis of an individual's rhythmicity and hence their ability to adjust their patterns to different types of shift systems. Given the strength of the circadian argument throughout the literature, and indeed, in many of the models of shiftwork tolerance, the TAQ had potential. Despite this, the measure failed to perform strongly. However, given the importance of circadian components in the field of shiftwork tolerance, future research should consider whether such results were due to the fact that (1) the TAQ lacked construct validity; (2) the components it measured were generally poor predictors of shiftwork tolerance; or (3) other variables such as circadian phase (as measured by the CTI), and type (as measured by the CMS), were stronger and possibly already encompassed the dimensions the TAQ purported to examine.

Continuing with this theme, whilst the studies here concentrated on circadian patterns and how these may affect tolerance to shifts, no attention was given to social variables as modifiers of shiftwork tolerance, highlighted in the majority of the models discussed in Chapter 4. Åkerstedt *et al.* (1976) and Knutsson *et al.* (1990) mention disturbed "sociotemporal patterns", Haider *et al.* (1988) incorporates "social environment", Monk (1988) "social and domestic factors", and Brown (1990) "family and social relations", whereas the studies performed here examined social life as a consequence of shiftwork. Given that social and domestic disruption showed wide-ranging associations with other outcome variables, future research needs to pursue its effects further.

In direct contrast to the scarcity of studies that directly compare males and females performing the same job, there exists a wealth of research findings and theory suggesting that females are less able to tolerate shiftwork. In Chapter 3 it was argued that it is extremely difficult to study purely gender-related effects of shiftwork tolerance (Epstein *et al.*, 1990; Oginska *et al.*, 1993) since males and females are often involved in different industries, the former typically employed in heavy manufacturing and engineering, and the latter predominating in healthcare, especially nursing. Although attempts were made in the present work to improve on this, by using cohorts with similar ratios of males and females, this nevertheless proved difficult. Gender emerged as a predictor of shiftwork preferences in Chapter 6 (where males were more likely to prefer daywork) and sleep duration between rest days in Chapter 8 (where females gained more sleep (Oswald, 1966; Wever, 1979)), although the amount of variance they explained was small. It is interesting to note, however, that gender only emerged in those studies where the proportion of females to males was relatively high. Future research needs to capitalise on this knowledge and strive for purely gender related effects by comparing men and women performing the same job, working the same shifts, under the same, or at the very least, comparable conditions.

Finally, perhaps the most important step in the battle towards understanding why some people are better able to tolerate shiftwork than others lies in the ability to design and conduct valid longitudinal research. Although such a paradigm was included here, the major weakness was the fact that many of the modifiers were not included in the follow-up questionnaires, making it impossible to establish whether changes in the outcome measures were due to exposure to the shift, or whether a similar change was also evident in the modifier variables. Similarly, as with correlation, regression analysis reveals relationships amongst variables, but does not imply that this is causal. Conducting longitudinal research, following workers either before or soon after they enter shiftwork and at regular follow-up points, would help to tackle a number of valuable questions. For example: At what point does adaptation take place? What are the key elements to successful adaptation? Do certain personality types only enter certain professions, in the same way that certain industries are predominated by different genders?

10.7. The Value of Models

Conceptual models of shiftwork tolerance have made important steps in combining our present knowledge to date to depict the manner in which problem areas relate both to the features of the shift systems and to one another. However, whilst such models are convenient for theoretically explaining the observed effects of research findings, their major drawback is that they often fail to represent the complex interrelationships between variables, or the subtle ways in which some variables strengthen or counteract others. Thus whilst such models are a good means of attempting to visualise the problems experienced by the shiftworker, they typically do so to the *point of oversimplification*, disguising the very intervening variables, dynamic relationships and multi-directional pathways that underlie the major difficulties.

Although models are theoretically valuable, a single model can never incorporate all features of shiftwork tolerance, amongst all shift systems and all industries. It is important to recognise that models do not have to be accurate and in many cases are not designed to be so. Indeed, most authors discussed in Chapter 4 emphasise that their models were presented to simplify or visualise the current state of knowledge and, therefore, to propagate further research. For example, Bunnage presents the model as a "guideline in the evaluation of research studies" (pp. 4), whilst Åkerstedt *et al.* present the model "to sort out some of the research components" (pp. 179) and use a simple abstract approach for doing so. In the same way Haider *et al.* state "the model is mainly hypothetical" (pp. 210), whilst Monk states that "no great claims are made for [the model's] originality, comprehensiveness or predictivity" and goes on to explain that it is intended to "provide a useful framework within which shiftwork research can be considered" (pp.197). Here the author is careful to point out that "the division is arbitrary and the factors interrelated, so much of the richness and complexity of the various forces and pressures will be lost" (pp. 197).

The true value of models lies in their ability to be manipulated in ways that are not appropriate or even ethical in real life situations. Models are constructed as substitutes of the real world, and thus, by their very nature, are abstract. Models exist to be explored and refined, and their underlying principle is the ability to take something from the real world and abstract it. Therefore, the simpler the model, the easier it is to manipulate, although the biggest downfall is that such models are less accurate or generalisable to specific situations. Whilst more detailed models remedy this, they are not necessarily better, since as more information is added, the more accurate and specific to certain cohorts it becomes. Thus, depending on the purpose of the model, adding detail may be a matter of diminishing returns.

Regardless of such arguments it is undeniable that models propagate interest by encapsulating a wealth of findings into an attractive formula, thereby generating arguments, criticisms and ideas for future research. Whilst more contemporary models are beginning to embrace the multi-directional nature of relationships between outcome and modifier variables, we must not forget the true value of early attempts to depict such interactions, since without these it is unlikely that the area would have evolved in this way. In applied settings, such as shiftwork tolerance, where research efforts can make a real difference to thousands of people in both their work and non-work lives, their contribution is priceless.

According to Parkes (1982) it is difficult to conclude whether the problems of shiftwork are the cause or effect of differences in adaptation. The wealth of knowledge we now hold is a key asset in gaining a happy-productive workforce, but only if we can better understand the processes and interactions between variables. Models of shiftwork tolerance highlight the great need to explore the pathogenic processes from shiftwork to its outcomes, and thus future research must build on the knowledge they provide. Only then can we begin to put this knowledge into practise.

> "Models do not make the job of decision making any easier. They make it harder. They enforce rigorous thinking and expose fallacies in mental models we have always been proud of. We think it is worth it. We think it pushes our mental models to be a bit closer to reflecting the world as it is"
>
> (Meadows, Richardson and Bruckmann, 1982)

REFERENCES

A

Aanonsen, A. (1959). Medical problems of shiftwork. *Industrial Medicine and Surgery*, **28**, 422-427.

Aanonsen, A. (1964). Shiftwork and health. Universiteforlaget, Oslo.

Aanonsen, A. (1976). Shiftwork and health. Universiteforlaget, Oslo.

Abelsdorff, W. (1910). Die Unfallhaufigkeit in den gewerblichen Betrieben wahrend der Nachtschicht. Vogel: Leipzig.

Abramson, I. Y., Seligman, M. E. P., and Teasdale, J. D. (1978). Learned helplessness in people: Critique and reformulation. *Journal of Abnormal Psychology*, **87**, 49-74.

Accident Prevention Advisory Unit (1981). *Managing Safety*. HMSO: London.

Adams, C. E., and Morgan, K. J. (1981). Periodicity of eating: Implications for human food consumption. *Nutrition Research*, **1**, 525-550.

Adams, N. L., Barlow, A., and Middlestone, J. (1981). Obtaining ergonomics information about industrial injuries: a five year analysis. *Applied Ergonomics*, **12**, 71-81.

Adan, A. (1992). The influence of age, work schedule, and personality on morningness dimension. *International Journal of Psychophysiology*, **12**, 95-99.

Adan, A. (1994). Chronotype and personality factors in the daily consumption of alcohol and psychostimulants. *Addiction*, **89**, 455-462.

Adan, A., and Almirall, H. (1990). Adaptation and standardisation of a Spanish version of the morningness-eveningness questionnaire: individual differences. *Personality and Individual Differences*, **11**, 1223-1230.

Adan, A., and Almirall, H. (1991). Horne and Ostberg morningness-eveningness questionnaire: a reduced scale. *Personality and Individual Differences*, **12**, 241-253.

Adeniran, R., Healy, D., Sharp, H., Williams, J. M. G., Minors, D., and Waterhouse, J. M. (1996). Interpersonal sensitivity predicts depressive symptom response to the circadian rhythm disruption of nightwork. *Psychological Medicine*, **26**, 1211-1221.

Agervold, M. (1976). Shift work – a critical review. *Scandinavian Journal of Psychology*, **17**, 181-188.

Aguair, G. F., Silva, H., and Marques, N. (1991). Patterns of daily allocation of sleep periods: A case study in an Amazonian riverine community. *Chronobiologia*, **18**, 9-19.

Åkerstedt, T., (1979). Altered Sleep/Wake Patterns and Circadian Rhythms: Laboratory and field studies of sympathoadrenomedullary and related variables. *Acta Psychologica Scandinavia*, **469**, 1-48.

Åkerstedt, T. (1980). Interindividual differences in adjustment to shiftwork. In W. P. Colquhoun and J. Rutenfranz (Eds.). *Studies of Shiftwork.* London: Taylor and Francis.

Åkerstedt, T. (1985). Adjustment of Physiological Circadian Rhythms and the Sleep-Wake Cycle to Shiftwork. In S. Folkard, S. and T. H. Monk, T. H. (Eds.) *Hours of Work: Temporal Factors in Work-Scheduling.* John Wiley and Sons: Chichester, pp.185-178.

Åkerstedt, T. (1990). Psychological and psychophysiological effects of shift work. *Scandinavian Journal of Work Environment and Health*, **16**, 67-73.

Åkerstedt, T. (1991). Shift Work and Sleep Disturbances. In J. H. Peter, T. Penzel, T. Podszus and P. von Wichert (Eds.). *Sleep and Health Risk.* Springer-Verlag: Berlin, pp. 265-278.

Åkerstedt, T. (1991). Sleepiness at work: effects of irregular work hours. In T. H. Monk (Ed.), *Sleep, Sleepiness and Performance.* John Wiley and Sons: Chichester, pp.129-152.

Åkerstedt, T. (1995). Work injuries and time of day – national data. *Shiftwork International Newsletter*, **12**, 2.

Åkerstedt, T. (1996). Wide awake at odd hours. Swedish Council for Work Life Research: Stockholm.

Åkerstedt, T. (1998). Is there an optimal sleep-wake pattern in shift work? *Scandinavian Journal Of Work Environment And Health*, **24**, 18-27.

Åkerstedt, T., Arnetz, B. B., and Anderzén, I. (1990). Physicians during and following night call duty – 41 hour ambulatory recording of sleep. *Electroencephalography and clinical Neurophysiology*, **76**, 193-196.

Åkerstedt, T. and Folkard, S. (1996). Predicting duration of sleep from the three-process model of alertness regulation. *Journal of Occupational and Environmental Medicine*, **53**, 136-141.

Åkerstedt, T. and Folkard, S. (1996). Predicting sleep latency from the three-process model of alertness regulation. *Psychophysiology*, **33**, 385-389.

Åkerstedt, T. and Fröberg, J. (1976). Shift work and health – interdisciplinary aspects. In P. G. Rentos and R. D. Shepard (Eds.). *Shiftwork and Health.* US Department of Health, Education and Welfare: Washington DC, pp.179-197.

Åkerstedt, T. and Gillberg, M. (1980). Sleep disturbances and shift work. In A Reinberg (Ed.), *Advances in studies on night and shift work.* Pergamon Press: Oxford, pp. 97-121.

Åkerstedt, T. and Gillberg, M. (1981). Sleep Disturbances and Shift Work. In A. Reinberg, N. Vieux and P. Andlauer (Eds.) *Night and Shift Work: Biological and Social Aspects.* Pergamon Press: Oxford, pp.127-137.

Åkerstedt, T. and Gillberg, M. (1981). The circadian variation of experimentally displaced sleep. *Sleep*, **4**, 159-169.

Åkerstedt, T. and Gillberg, M. (1982). Experimentally displaced sleep: effects on sleepiness. *Electroencephalography and Clinical Neurophysiology*, **54**, 220-226.

Åkerstedt, T. and Gillberg, M. (1985). Sleepiness and shift work: Field studies. *Sleep*, **5**, 95-106.

Åkerstedt, T. and Gillberg, M. (1986). A dose response study of sleep loss and spontaneous sleep termination. *Psychophysiology*, **23**, 293-297.

Åkerstedt, T. and Gillberg, M. (1986). Sleep duration and the spectral power density of the EEG. *Electroencephalography and Clinical Neurophysiology*, **64**, 119-122.

Åkerstedt, T., T., Gillberg, M. and Kecklund, G. (1990). Day Sleep and Shift Work. In J. Horne (Ed.) *Sleep*. Pontenagel Press: Bochum, pp.329-331.

Åkerstedt, T., T., Kecklund, G., and Knutsson, A. (1991). Spectral analysis of sleep encephalography in rotating three-shift work. *Scandinavian Journal of Work Environment And Health*, **17**, 330-336.

Åkerstedt, T., T., Kecklund, G., and Knutsson, A. (1991). Manifest Sleepiness and the Spectral Content of the EEG during Shift Work. *Sleep*, **14**, 221-225.

Åkerstedt, T. and Knutsson, A. (1997). Cardiovascular disease and shiftwork. *Scandinavian Journal of Work Environment and Health*, **23**, 241-242.

Åkerstedt, T. and Torsvall, L. (1977). Medical, psychological, and social aspects of shift work in the steel mill of Soderfors, Report 1: A survey of complaints, summary of results (in Swedish*). Rapporter fran Laboratoriet for Klinisk Stressforskning Institutet Stockholm*, Nr. 53b.

Åkerstedt, T. and Torsvall, L. (1980). Age, Sleep and Adjustment to Shiftwork. *5th European Congress on Sleep Research*, Amsterdam, 1980, pp.190-195.

Åkerstedt, T. and Torsvall, L. (1981). Shift work; shift dependent well-being and individual differences. *Ergonomics*, **24**, 265-273.

Åkerstedt, T. and Torsvall, L. (1985). Napping in shift work. *Sleep*, **8**, 105-109.

Åkerstedt, T., Torsvall, L., and Gillberg, M. (1981). Napping and irregular work hours. *Sleep Research*, **10**, 132.

Åkerstedt, T., Torsvall, L., and Gillberg, M. (1982). Sleepiness and shiftwork: Field studies. *Sleep*, **5**, 95-106.

Alfredsson, L., Karasek, R., and Theorell, T. (1982). Myocardial infarction risk and psychosocial work environment: an analysis of the male Swedish working force. *Social Science Medicine,* **16**, 463-467.

Alfredsson, L., Knutsson, A., Siegrist, J., and Westerholm, P. (1999). Does a stressful psychosocial work environment mediate the effects of shift work on cardiovascular risk factors? *Scandinavian Journal of Work Environment and Health*, **25**, 376-381.

Alfredsson, L., Spetz, L., and Theorell, T. (1985). Type of occupation and near-future hospitalisation for myocardial infarction and some other diagnoses. *International Journal of Epidemiology*, **14**, 378-388.

Ambert, A. M. (1976). Sex structure. Longman: Canada.

American Psychiatric Association (1987). Diagnostic and statistical manual of mental disorders (3rd Ed. Revised) Washington, DC, American Psychiatric Association.

Andersen, J. E. (1957). The main result of the Danish medico-psychosocial investigation of shiftworkers. *XII International Congress On Occupational Medicine*, Helsinki, Vol. 3, pp.135-136.

Andersen, J. E. (1970). Treskiftsarbejde [A Sociomedical Study]. Socialforskningsinstituttet: Copenhagen.

Andersen, H., Chambers, M. M. C., Myhre, G., Nicholson, A. N., and Stone, B. M. (1984). Sleep of Shiftworkers within the Arctic Circle. *Aviation, Space and Environmental Medicine*, 1026-1030.

Andersen, R. M., and Bremer, D. A. (1987). Sleep Duration at Home and Sleepiness on the Job in Rotating Twelve-Hour Shift Workers. *Human Factors*, **29**, 477-481.

Andlauer, P., and Metz, B. (1967). Le travail en equipes alternantes. In J. Scherrer (Ed.), *Physiologie du travail – ergonomic*. Masson: Paris, pp.272-281.

Andlauer, P., and Reinberg, A. (1979). Amplitude of the oral temperature circadian rhythm and tolerance to shiftwork. *Chronobiologia*, **6**, 67-73.

Angersbach, D., Knauth, P., Loskant, H., Karvonen, M. J., Undeutsch, K., and Rutenfranz, J. (1980). A Retrospective Cohort Study Comparing Complaints and Diseases in Day and Shift Workers. *International Archives of Occupational and Environmental Health*, **45**, 127-140.

Angiboust, R., and Govars, M. (1972). Tentative d'evaluation de l'efficacite operationelle du personnel de l'aeronautique militaire au cours de veilles nocturnes. In W. P. Colquhoun (Ed.), *Aspects of Human Efficiency: Diurnal Rhythm, and Loss of Sleep*. English Universities Press: London, pp.151-170.

Armstrong, B. G., Nolin, A. D., and McDonald, A. D. (1989). Work in pregnancy and birth weight for gestational age. *British Journal of Industrial Medicine*, **46**, 196-199.

Armstrong, D. (1982). An evaluation of the influence of experience on permanent day and permanent night shift workers. Unpublished Masters thesis, Illinois Institute of Technology: Chicago.

Armstrong, S. (1980). A Chronometric approach to the study of feeding behaviour. *Neuroscience and Biobehavioural Reviews*, **4**, 27-53.

Arvey, R. D., Bouchard, T. J., Segal, N.L., and Abraham, L.M. (1989). Job satisfaction: Environmental and genetic components. *Journal of Applied Psychology*, **74**, 187-192.

Arvey, R. D., and Campion, J. E. (1982). The employment interview: A summary and review of recent *research*. *Personnel Psychology*, **35**, 281-322.

Aschoff, J. (1978b). Problems of re-entrainment of circadian rhythms: Asymmetry effect, dissociation and partition. In J. Assenmacher, and D. S. Farner (Eds.). *Environmental Endocrinology*. Springer Verlag: New York, pp. 185-195.

Aschoff, J. (1985). On the perception of time during prolonged temporal isolation. *Human Neurobiology*, **4**, 41-52.

Aschoff, J. (1997). Human time perception in temporal isolation: effects of illumination intensity. *Chronobiology International*, **14**, 585-596.

Aschoff, J. (1998a). Circadian parameters as individual characteristics. *Journal of Biological Rhythms*, **13**, 123-131.

Aschoff, J. (1998b). Human perception of short and long time intervals: its correlation with body temperature and the duration of wake time. *Journal of Biological Rhythms*, **13**, 437-442.

Aschoff, J., Hoffman, K., Pohl, H., and Wever, R. (1975). Re-entrainment of circadian rhythms after phase shifts of the zeitgeber. *Chronobiologia*, **2**, 23-78.

Aschoff, J. and Pohl, H. (1978). Phase relations between a circadian rhythm and its zeitgeber within the range of entrainment. *Naturwissenschaften*, **65**, 80-84.

Astrup, P., and Kjeldsen, K. (1974). Carbon monoxide smoking and arteriosclerosis. Symposium on Arteriosclerosis. *Med. Clin. North America*, **58**, 323-350.

Atkinson, R. L., Atkinson, R. C., Smith, E. E., Bem, D. J., and Nolen-Hoeksema, S. (Eds.). *Introduction to Psychology*. Fort Worth: Harcourt Brace Jovanovich.

Axelsson, G., Ahlborg, G Jr, and Bodin, L. (1996). Shift work, nitrous oxide exposure, and spontaneous abortion among Swedish midwives. *Occupational and Environmental Medicine*, **53**, 374-378.

Axelsson, G., Rylander, R., and Molin, I. (1989). Outcome of pregnancy in relation to irregular and inconvenient work schedules. *British Journal of Industrial Medicine*, **46**, 393-398.

Axelsson, M. A., Kecklund, G., Åkerstedt, T., and Lowden, A. (1998). Effects of alternating 8- and 12-hour shifts on sleep, sleepiness, physical effort and performance. *Scandinavian Journal of Work Environment and Health*, **24**, 62-68.

B

Baer, K., Ernst, G., Schay, T., and Nachreiner, F. (1981). Psychologische Ansatze zur Analyse verschiedener Arbeitszeitsysteme. *Zeichschrift fur Arbeitwissenschaft*, **35**, 136-141.

Banks, O. (1956). Continuous shiftwork: the attitudes of wives. *Occupational Psychology*, **30**, 69-84.

Barnes, R. G., Forbes, M. J., and Arendt, J. (1998). Shift type and season affect adaptation of the 6-sulphatoxymeltonin rhythm in offshore oil rig workers. *Neuroscience Letters*, **252**, 179-182.

Barton, J., Aldridge, J., and Smith, P. (1998). The emotional impact of shift work on the children of shift workers. *Scandinavian Journal of Work Environment and Health*, **24**, 146-150.

Barton, J., and Folkard, S. (1993). Advancing versus delaying shift systems. *Ergonomics*, **36**, 59-64.

Barton, J., Smith, L. R., Totterdell, P., Spelten, E., and Folkard, S. (1993). Does individual choice determine shift system acceptability? *Ergonomics*, **36**, 93-99.

Barton, J., Spelten, E., Totterdell, P., Smith, L., and Folkard, S. (1995). Is there an optimum number of night shifts? Relationship between sleep, health and well-being. *Work and Stress*, **9**, 109-123.

Barton, J., Spelten, E., Totterdell, P., Smith, L., and Folkard, S., and Costa, G. (1995). The Standard Shiftwork Index: a battery of questionnaires for assessing shiftwork-related problems. *Work and Stress*, **9**, 4-30.

Beerman, B., and Nachreiner, F. (1995). Working shifts – different effects for women and men? *Work and Stress*, **9**, 289-297.

Beerman, B., Rutenfranz, J., and Nachreiner, F. (1990). Gender related effects of shiftwork? An analysis of some confounding variables. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.). *Shiftwork, Health, Sleep and Performance*. Peter Lang: Frankfurt.

Beerman, B., Schmidt, K. H., Rutenfranz, J. and Saito, Y. (1981). Effects of working time conditions and family background on daily activity patterns in a group of shiftworking nurses. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.), *Shiftwork: Health, Sleep, and Performance*. Peter Lang: Frankfurt, pp.52-55.

Benedito-Silva, A. A., Menna-Barreto, L. S., Cipolla-Neto, J., Marques, N., and Tenreiro, S. (1989). A self-evaluation questionnaire for the determination of morningness-eveningness types in Brazil. *Chronobiologia*, **16**, 113.

Bentall, R. P., Wood, G. C., Marrinan, T., Deans, C., and Edwards, R. H. T. (1993). A brief mental fatigue questionnaire. *British Journal of Clinical Psychology*, **32**, 375-379.

Ben-Zur, H., and Zeidner, M. (1996). Gender differences in coping reactions under community crisis and daily routine conditions. *Personality and Individual Differences*, **20**, 331-340.

Bertelson, .A. D. (1979). *Effects of napping and bedrest on performance and mood*. PhD dissertation. Ohio State University.

Billings, A. G., and Moos, R. H. (1981). The role of coping responses and social resources in attenuating the stress of life events. *Journal of Behavioural Medicine*, **4**, 139-157.

Bjerner, B., Holm, A., and Swensson, A. (1948). Om natt och skiftarbete. *Statens Offentliga Utredningar* (Stockholm), **51**, 87-159.

Bjerner, B., Holm, A., and Swensson, A. (1955). Diurnal variation in mental performance. *British Journal of Industrial Medicine*, **12**, 103-110.

Blackburn, C. A., Moffitt, C. M., White, D. W., and Smolensky, M. H. (1980). Temporal variation in the susceptibility of mice to Diazinon. Proceedings of the XIV International Congress of Chronobiology. Hannover, Germany.

Blake, M. J. F. (1967). Relationship between circadian rhythm of body-temperature and introversion-extroversion. *Nature*, **215**, 896-897.

Blake, M. J. F. (1967). Time of day effects on performance in a range of tasks. *Psychonomic Science*, **9**, 349-350.

Blake, M. J. F., and Corcoran, D. W. J. (1972). Introversion-extraversion and circadian rhythms. In P. Colquhoun (Ed.), *Aspects of human efficiency*. English Universities Press: London, pp. 261-272.

Blakelock, E. (1960). A new look at the new leisure. *Administrative Science Quarterly*, **4**, 446-467.

Bohle, P. (1990). The impact of night work: individual differences in subjective health. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.), *Shiftwork: Health, Sleep, and Performance*. Peter Lang: Frankfurt, pp.56-61.

Bohle, P., and Tilley, A. J. (1989). The impact of night work on psychological well being. *Ergonomics*, **32**, 1089-1099.

Bohle, P., and Tilley, A. J., (1993). Predicting mood change on night shift. *Ergonomics*, **36**, 125-133.

Bohle, P., and Tilley, A. J. (1998). Early experiences of shiftwork: Influences on attitudes. *Journal of Occupational and Organisational Psychology*, **71**, 61-79.

Bonitz, D., Grzech-Sukalo, H., and Nachreiner, F. (1988). Differential psychosocial effects of different shift systems. In A. Oginsky, J. Pokorski and J. Rutenfranz (Eds.), *Contemporary Advances in Shiftwork Research: Theoretical and Practical Aspects in the Late Eighties*. Proceedings of the 8th International Symposium on Night- and Shiftwork. Krakow/Koninki, Poland, 22-26 June, 1987. Peter Lang: Frankfurt, pp.181-189.

Bonnet, M. H. (1991). The effect of varying prophylactic naps on performance, alertness and mood throughout a 52-hour continuous operation. *Sleep*, **14**, 307-315.

Bonnet, M. H., and Arand, D. L. (1994). The use of prophylactic naps and caffeine to maintain performance during a continuous operation. *Ergonomics*, **37**, 1009-1020.

Bonnet, M. H., and Arand, D. L. (1995) Consolidated and distributed nap schedules and performance. *Journal of Sleep Research*, **4**, 71-77.

Borbély, A. A., Baumann, F., Brandeis, D., Strauch, I., and Lehmann, D. (1981). Sleep deprivation: effects on sleep stages and EEG power density in man. *Electroencephalography and Clinical Neurophysiology*, **51**, 483-493.

Bosma, H., Peter, R., Siegrist, J., and Marmot, M. (1998) Two alternative job stress models and the risk of coronary heart disease. *American Journal of Public Health*, **88**, 68-74.

Bosworth, D. (1994). Shiftwork in the UK: evidence from the LFS. *Applied Economics*, **26**, 617-626.

Brand, A. and Hirsch, B. J. (1990). The contribution of social networks, work-shift schedules, and the family life cycle on women's well-being. In S. Duck (Ed.), *Personal relationships and social support*. Sage: Newbury Park (CA).

Breithaupt, H., Hildebrandt, G., Dohre, D., Josch, R., Sieber, U., and Werner, M. (1978). Tolerance to shift of sleep, as related to the individual's circadian phase position. *Ergonomics*, **21**, 767-774.

Brems, C., and Johnson, M. E. (1989). Problem-solving appraisal and coping style: The influence of sex-role orientation and gender. *Journal of Psychology*, **123**, 187-194.

Brewin, C. (1988). *Cognitive foundations of clinical psychology*. London: Lawrence Erlbaum.

Brown, D. (1975). Shiftwork: a survey of the sociological implications of studies of male shiftworkers. *Journal of Occupational Psychology*, **48**, 231-240.

Brown, F. M. (1981). Two-factor illumination-effect hypothesis for viability decreases in animals under altered 24 hour days. In F. Halberg, L. Scheving, I. Powell and D. K. Hayes (Eds.), Chronobiology: Proceedings of the 13th International Conference, Pavia. Milan: II Ponte, pp. 91-96.

Brown, F. M. (1982). Rhythmicity as an emerging variable for psychology. In F. M. Brown and R. C. Graeber (Eds.), *Rhythmic Aspects of Behaviour*. Lawrence Erlbaum: Hillsdale, NJ, pp.1-38.

Brown, F. M. (1990). A Five-Factor Model of Viability for Shiftworkers. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.), *Shiftwork: Health, Sleep, and Performance*. Peter Lang: Frankfurt, pp.356-361.

Brown, H. G. (1959). Some effects of shift work on social and domestic life. Yorkshire Bulletin of Economic and Social Research. Occasional Paper, No. 2.

Brown, R. C. (1949). The day and night performance of teleprinter switchboard operators. *Occupational Psychology*, **23**, 121-126.

Brown, D., and Charles, N. (1982). Women and Shiftwork: Some Evidence from Britain. European Foundation for the Improvement of Living and Working Conditions: Dublin.

Brugere, D., Barrit, J., Butat, C., Cosset, M., and Volkoff, S. (1997). Shiftwork, age, and health: an epidemiologic investigation. *International Journal of Occupational and Environmental and Health*, **3**, 15-19.

Bruusgaard, A. (1949). Shiftworkers: Recommendations on the Shortening of Working Hours in Certain Occupations. Ministry of Local Government and Labour: Oslo.

Bryden, G., and Holdstock, T. L. (1973). Effects of night duty on the sleep patterns of nurses. *Psychophysiology*, **10**, 36-42.

Buela-Casal, G., Caballo, V. M., and Garcia Cueto, E. (1990). Differences between morning and evening types in performance. *Personality and Individual Differences*, **11**, 447-450.

Buell, G. C., and Elliot, R. S. (1980). Psychological and behavioural influences in the pathogenesis of acquired cardiovascular disease. *American Heart Journal, 112*, 723-740.

Bullock, N., Dickens, P., Shapcott, M., and Steadman., P. (1974). Time budgets and models of urban activity patterns. *Social Trends*, **5**, 45-63. HMSO: London.

Bunnage, D. (1984). The consequences of shiftwork on social family life. In A. Wedderburn and P. Smith (Eds.), *Psychological approaches to night and shift work*. Seminar Paper No. 7. Heriot-Watt University, Edinburgh.

Burchell, B. (1994). The effects of labour market position, job security and unemployment on psychological health. In D. Gallie, C. Marsh, and C.Vogler, (Eds.), *Social change and the experience of unemployment*. Oxford University Press: Oxford.

Buunk, B., and Peters, M. C. W. (1994). Stress at work, social support and companionship: Towards an event contingent recording approach. *Work and Stress*, **8**, 177-190.

C

Candido, C. L., and Romney, D. M. (1990). Attributional style in paranoid vs. depressed patients. *British Journal of Medical Psychology*, **63**, 355-363.

Carlson, N. R. (1991). *Physiology of Behaviour*. Allyn and Bacon: Boston.

Carpentier, J., and Cazamian, P. (1977). Le Travail de Nuit. International Labour Office: Geneva.

Carrier, J., Monk, T. H., Buysse, D. J., and Kupfer, D. J. (1997). Sleep and morningness-eveningness in the 'middle' years of life (20-59y). *Journal of Sleep Research*, **6**, 230-237.

Carskadon, M. A., and Dement, W. C. (1975). Sleep studies on a 90-minute day. *Electroencephalography and Clinical Neurophysiology*, **39**, 145-155.

Carskadon, M. A., and Dement, W. C. (1986). Effects of a daytime nap on sleepiness during sleep restriction. *Sleep Research*, **16**, 69.

Carter, F. A., and Corlett, E. N. (1982). Shift-work and Accidents. European Foundation for the Improvement of Living and Working Conditions: Dublin.

Carver, C. S., Scheier, M. F., and Weintraub, J. K. (1989). Assessing coping strategies: A theoretically based approach. *Journal of Personality and Social Psychology*, **56**, 267-283.

Cervinka, R., Kundi, M., Koller, M., Haider, M., and Arnhof, J. (1984). Shift related nutrition problems. Psychological Approaches to Night and Shift Work: International Research Papers (Department of Business Organisation, Heriot-Watt University, Edinburgh).

Chambers English Dictionary (1997). Chambers Harrap Publishers: Cambridge.

Chan, O. Y., Phoon, W. H., Gan, S. L., and Ngui, S. J. (1989). Sleep-Wake Patterns and Subjective Sleep Quality of Day and Night Workers: Interaction Between Napping and Main Sleep Episodes. *Sleep*, **12**, 439-448.

Chaucard, P. (1968). La fatigue. Que sais-je?, No. 733, P. U. F. (Paris).

Chesson, A. L., Littner, M., Davila, D., Anderson, W. M., Grigg-Damberger, M., Hartse, K., Johnson, S., and Wise, M. (1999). Practise parameters for the use of light therapy in the treatment of sleep disorders. *Sleep*, **22**, 641-660.

Cho, K. (2001). Chronic 'jet lag' produces temporal lobe atrophy and spatial cognitive deficits. *Nature Neuroscience*, **4**, 567-568.

Clark, S. (1990). Shiftwork and leisure behaviour of ethnic and gender groups in the British textile industry. *Le travail humain*, **53**, 227-244.

Clarke, D. (1984). Types of household adjustment to rotating shiftwork: Employees in manufacturing industry. In A. Wedderburn and P. Smith (Eds.), *Proceedings of Psychological Approaches to Night and Shiftwork Meeting*, Heriot-Watt University, Edinburgh.

Cobb, S. (1976). Social support as a moderator of life stress. *Psychosomatic Medicine*, **38**, 300-314.

Coburn, E. (1996). Shiftworker Fatigue: The $77 Billion Problem. http://www.circadian.com/shiftworkerfatigue_text.htm

Coelho, R. J. (1980). A psychometric investigation of the multidimensional health locus of control scales and cigarette smokers. *Journal of Clinical Psychology*, **41**, 372-376.

Cohen, S. (1988). Psychosocial models of the role of social support in the etiology of physical disease. *Health Psychology*, **98**, 310-357.

Cohn, J. F., and Campbell, S. B. (1992). Influence of maternal depression on infant affect regulation. In D. Cicchetti and S. Toth (Eds.), Rochester Symposium on developmental psychopathology; vol. 4, (Developmental approaches to affective disorders). University of Rochester Press: Rochester (NY), pp.323-349.

Cole, R. J., Loving, R. T., and Kripke, D. F. (1990). Psychiatric aspects of shift-work. *Occupational Medicine* (Philadelphia), **5**, 301-314.

Colin-Jones, D. G., Ireland, A., and Gear, P. (1984). Reducing overnight secretion of acid to heal duodenal ulcers: comparison of standard divided dose of ranitidine with a single dose administered at night. *American Journal of Medicine*, **77**, 106-122.

Colligan, M. J., Frockt, I. J., and Tasto, D. L. (1979). Frequency of sickness absence and worksite clinic visits among nurses as a function of shift. *Applied Ergonomics*, **10**, 79-85.

Colligan, M. J., and Rosa, R. R. (1990). Shift work effects on social and family life. *Occupational Medicine*, **5**, 301-322.

Colquhoun, W. P. (1960). Temperament, inspection efficiency and time of day. *Ergonomics*, **3**, 377-378.

Colquhoun, W. P. (1976). Accidents, injuries and shift work. In P. G. Rentos and R. D. Shepard (Eds.) *Shiftwork and Health: A Symposium*. DHEW Publication No. NIOSH 76-203. Washington DC: US Government Printing Office.

Colquhoun, W. P., Blake, M. J. F., and Edwards, R. S. (1968). Experimental Studies of Shift-Work II: Stabilised Eight-Hour Shift Systems. *Ergonomics*, **11**, 527-546.

Colquhoun, W., P., Condon, R. (1981). Introversion-extraversion and the adjustment of the body temperature rhythm to night work. In A. Reinberg, N. Vieux and P. Andlauer (Eds.), *Night and Shiftwork: Biological and Social Aspects*. Pergamon Press: Oxford, pp. 223-28.

Colquhoun, W., P., Costa, G., Folkard, S., and P. Knauth (1996). *Shiftwork: problems and solutions*. Peter Lang: Frankfurt am Main.

Colquhoun, W. P., and Folkard, S. (1978). Personality differences in body temperature rhythms and their relation to its adjustment to night work. *Ergonomics*, **21**, 811-817.

Cook, C., Heath, F., and Thompson, R.L. (2000). A meta-analysis of response rates in web- or internet-based surveys. *Educational and Psychological Measurement*, **60**, 821-836.

Cooper C. L., and Sloan, S. J. (1985). Occupational and psychosocial stress among commercial aviation pilots. *Journal of Occupational Medicine*, **23**, 65-72.

Cooper, M. L., Russell, M., and Frone, M. R. (1990). Work stress and alcohol effects: A test of stress-induced drinking. *Journal of Health and Social Behaviour*, **31**, 260-276.

Costa, G. (1986). The impact of shift and night work on health. *Applied Ergonomics*, **27**, 9-16.

Costa, G. (1996). Effects on Health and Well-Being. In P. Colquhoun, G. Costa, S. Folkard and P. Knauth (Eds.), *Shiftwork: problems and solutions*. Peter Lang: Frankfurt am Main, pp.113-139.

Costa, G., Apolisti, P., D'Andrea, F., and Gaffuri, E. (1981). Gastrointestinal and neurotic disorders in textile shift workers. In A. Reinberg, N. Vieux and P. Andlauer (Eds.) *Night and Shift Work: Biological and Social Aspects*. Pergamon Press: Oxford, pp.215-232.

Costa, G., Bertoldi, A., Kovacic, M., Ghirlanda, G., Minors, D. S., and Waterhouse, J. M. (1997). Hormonal secretion of nurses engaged in fast-rotating shift systems. *International Journal of Occupational and Environmental Health*, **3**, 35-39.

Costa, G., Folkard, S., and Harrington, J. M. (2000). Shift work and extended hours of work. In P. J. Baxter, P. H. Adams, Aw. Tar-Ching, A. Cockroft and J. M. Harrington (Eds.), *Hunter's disease of occupations*. Arnold: London, pp.585-589.

Costa, G., and Gaffuri, E. (1983). Circadian rhythm behaviour characteristics and tolerance to shiftwork. *Chronobiologia*, **10**, 395.

Costa, G., Gaffuri, E., Ghirlanda, G., Minors, D. S., and Waterhouse, J. M. (1995). Psychophysical conditions and hormonal secretion in nurses on a rapidly rotating shift schedule and exposed to bright light during night work. *Work and Stress*, **9**, 148-157.

Costa, G., Lievore, F., Casaletti, G., Gaffuri, E. and Folkard, S. (1989). Circadian characteristics influencing interindividual differences in tolerance and adjustment to shiftwork. *Ergonomics*, **32**, 373-385.

Costa, G., Lievore, F., Ferrari, P., and Gaffuri, E. (1987). Usual meal times in relation to age, sex, work activity and morningness-eveningness. *Chronobiology*, **14**, 383-391.

Costa, P. T., and McCrae, R. R. (1985). Hypochondriasis, neuroticism, and aging: When are somatic complaints unfounded? *American Psychologist*, **40**, 19-28.

Costa, P. T., and McCrae, R. R. (1987). Neuroticism, somatic complaints, and disease: is bark worse than the bite? *Journal of Personality*, **55**, 299-316.

Costa, G., Micciloi, R., Bertoldi, L., and Tommasini, M. (1990). Absenteeism of female and male nurses on day and shiftwork. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.). *Shiftwork, Health, Sleep and Performance*. Peter Lang: Frankfurt.

Costa, G., Olivata, D., Peroni, E., Mossini, E., and Gonella, C. (1991). Problems associated to the introduction of night work in a group of female workers of a food industry. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.), *Shiftwork: Health, Sleep, and Performance*. Peter Lang: Frankfurt, pp.68-77.

Covey, L. S., and Wynder, E. L. (1981). Smoking habits and occupational status. *Journal of Occupational Medicine*, **23**, 537-542.

Cox, S., Cox., T., and Pryce, J. (2000). Work-related reproductive health: a review. *Work and Stress*, **14**, 171-180.

Cummings, E. M., and Davies, P. T. (1994). Maternal depression and child development. *Journal of Child Psychology and Psychiatry*, **35**, 73-112.

Cummings, R. O., Shaper, A. G., Walker, M., and Wale, C. J. (1981). Smoking and drinking by middle aged British men: Effects of social class and town of residence. *British Medical Journal*, **283**, 1479-1502.

Czeisler, C., and Allan, J. (1987). Acute Circadian Phase Reversal in Man Via Bright Light Exposure: Application to Jet Lag. *Sleep Research*, **16**, 605.

Czeisler, D. A., Weitzman, E. D., Moore-Ede, J. G., M. C., Zimmerman, J. C., and Knauer, R. S. (1980). Human sleep: its duration and organisation depend on its circadian phase. *Science*, **210**, 1164-1167.

D

Dalbokova, D., Tzenova, B., and Ognjanova, V. (1995). Stress states in nuclear operators under conditions of shiftwork. *Work and Stress*, **9**, 305-313.

Dahlgren, K. (1981). Adjustment of Circadian Rhythms to Rapidly rotating shift work – a field study of the two shift systems.. In A. Reinberg, N. Vieux and P. Andlauer (Eds.) *Night and Shift Work: Biological and Social Aspects*. Pergamon Press: Oxford, pp.357-364.

Dahlgren, K. (1981a). Adjustment of circadian rhythms and EEG sleep functions to day and night sleep among permanent night workers and rotating shift workers. *Psychophysiology*, **18**, 381-391.

Dahlman, T. (1953). The incidence of peptic ulcer and chronic gastritis among Swedish sea pilots. *British Journal of Industrial Medicine*, **10**, 157-160.

Daniel, J., and Potašová, A. (1989). Oral temperature and performance in 8h and 12h shifts. *Ergonomics*, **32**, 689-696.

David, M. M., Maclaen, A. W., Knowles, J. B., and Coulter, M. E. (1991). Rapid eye movement latency and mood following a delay in bedtime in healthy subjects: do the effects mimic the changes in depressive illness? *Acta Psychiatric Scandinavia*, **84**, 33-39.

Dawson, D., and Reid, K. (1997). Fatigue, alcohol and performance impairment. *Nature*, **388**, 325.

Debry, G., and Bleyer, R. (1972). Influence des trois-huit sur l'ailmentation des travailleurs. Alimentation et travail: Symposium International, pp.153-176.

Debry, G., Girault, P., Lefort, L., and Thiebault, J. (1967). Enquete sur les Habitudes Alimentaires des Travailleurs 'a Feux Continus'. *Bulletin de l'INSERM*, **22**, 1169-1202.

De Jonge, J., and Kompier, M. A. J. (1987). A Critical examination of the demand-control-support model from a work psychological perspective. *International Journal of Stress Management*, **4**, 235-258.

Dekker, D. K., Paley, M. J., Popkin, S. M., and Tepas, D. I. (1993). Locomotive engineers and their spouses: coffee consumption, mood and sleep reports. *Ergonomics*, **36**, 233-238.

De la Mare, G., and Walker, J. (1968). Factors influencing the choice of shift rotation. *Occupational Psychology*, **42**, 1-21.

de Vries-Griever, A. H., and Meijman, Th. F. (1987). The impact of abnormal hours of work on various modes of information processing: a process model on human costs of performance. *Ergonomics*, **30**, 1287-1299.

Diagnostic Classification Steering Committee: International Classification of Sleep Disorders. Rochester, Minnesota. American Sleep Disorders Association, 118.

Diekmann, A., Ernst, G., Nachreiner, F., and Volger, A. (1981). Auswirkung der Schichttarbeit der Vaters auf die schulische Entwicklung der Kinder. *Zeichschrift fur Arbeitwissenschaft*, **35**, 174-178.

Dijk, D. J., and Czeisler, C. A. (1994). Paradoxical timing of the circadian rhythm of sleep propensity serves to consolidate sleep and wakefulness in humans. *Neuroscience Newsletters*, **166**, 63-68.

Dijk, D. J., and Czeisler, C. A. (1995). Contribution of the circadian pacemaker and the sleep homeostat to sleep propensity, sleep structure, electroencephalographic slow waves, and sleep spindle activity in humans. *Journal of Neuroscience*, **15**, 3526-3528.

Dinges, D. F., and Kribbs, N. B. (1991). Performing while sleepy: effects of experimentally induced sleepiness. In T. H. Monk (Ed.), *Sleep, Sleepiness and Performance*. Wiley: Chichester, pp.119-128.

Dinges, D. F., Orne, E. C., Evans, F. J., and Orne, M. T. (1981a). Performance after naps in sleep-conducive and alerting environments. In L. C. Johnson, D. I. Tepas and W. P. Colquhoun and M. J. Colligan (Eds.), *Biological Rhythms, Sleep and Shift Work*. Spectrum Medical and Scientific Books: New York, pp.539-552.

Dirkx, J. (1987). A comparison of experienced shiftworkers with and without health complaints. In A. Oginska, J. Pokorski, and J. Rutenfranz (Eds.). *Contemporary Advances in Shiftwork Research*. Medical Academy, Krakow.

Dix, T. (1991). The affective organisation of parenting: adaptive and maladaptive processes. *Psychological Bulletin*, **110**, 3-25.

Downey, G., and Coyne, J. C. (1990). Children of depressed parents: an integrative review. *Psychological Bulletin*, **108**, 50-76.

Duchon, J. C., and Keran, C. M. (1990). Relationships among shiftworker eating habits, eating satisfaction, and self-reported health in a population of US miners. *Work and Stress*, **4**, 111-120.

Duesberg, R., and Weiss, W. (1939). Reichsgesundheitsblatt. *Arbeitsschutz*, **3**, 8.

Dumont, M., Montplaisir, J., and Infante-Rivard, C. (1997). Sleep Quality of Former Night-shift Workers. *International Journal of Occupational and Environmental Health*, **3**, 10-14.

Dunkel-Schetter, C., Folkman, S., and Lazarus, R. S. (1987). Correlates of social support receipt. *Journal of Personality and Social Psychology*, **53**, 71-80.

E

Eiser, J. R., Eiser, C., Gammage, P., and Morgan, M. (1989). Health locus of control and health beliefs in relation to adolescent smoking. *British Journal of Addiction*, **84**, 1059-1065.

Elovainio, M., Kivimaki, M., Steen, M., and Kalliomaki-Levanto, T. (2000). Organizational and individual factors affecting mental health and job satisfaction: a multilevel analysis of job control and personality. *Journal of Occupational Health Psychology*, **5**, 269-277.

Ely, D. L., and Mostardi, R. A. (1986). The Effect of Recent Life Events Stress, Life Assets, and Temperament Pattern on Cardiovascular Risk Factors for Akron City Police Officers. *Journal of Human Stress*, 77-91.

Emilien, G., and Maloteaux, J. M. (1999). Circadian system and sleep anomaly in depression. *Irish Journal of Psychological Medicine*, **16**, 18-23.

Emura, N., Kuroda, K., Satani, S., Mandai, M., Itaya, K., and Yoshida, Y. (1996). The effect of bright light exposure and the seasonal change in short sleep-wake cycle. *Journal of Sleep Research*, **5**, 59.

Engel, R. R., Muller, F., Munch, V., and Ackenheil, M. M. (1980). Plasma catecholamine response and autonomic functions during short-time psychological stress. In E. Ursin, R. Kvetnansky and I. Kopin (Eds.), *Catecholamines and Stress, Recent Advances*. Elsevier: Holland, pp.461-466.

Epstein, R., Tzischinsky, O., Chillag, N., and Lavie, P. (1990). Rotating shift-worker women in microelectronic factory. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.). *Shiftwork, Health, Sleep and Performance*. Peter Lang: Frankfurt.

Ernst, G., Nachreiner, F., and Volger, A. (1986). Applicability of shift work research to problems of irregular working hour. In M. Haider, M. Koller and R. Cervinka (Eds.), *Night- and Shiftwork: Longterm Effects and Their Prevention*. Proceedings of the 7th International Symposium on Night- and Shiftwork, Igls, Austria, 1985. Peter Lang: Frankfurt, pp.261-268.

Estryn-Behar, M., Gadbois, C., Peigne, E., Masson, A., and Le Vall, V. (1990). Impact of nightshifts on male and female hospital staff. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.). *Shiftwork, Health, Sleep and Performance*. Frankfurt am Main: Peter Lang, pp. 89-94.

European Community (1997). Consolidated Version Of The Treaty Establishing The European Community (as Amended by the Treaty of Amsterdam). Luxembourg: Office for Official Publications of the European Communities

European Council (1993) Council Directive 93/104/EC of 23 November 1993 concerning certain aspects of the organization of working time. Official Journal, L307, 13/12/1993 pp.18-24

European Council (1998) Working Time Regulations. UK Statutory Instrument 1998 No. 1833, HSMO.

Eysenck, M. W., and Folkard, S. (1980). Personality, time of day, and caffeine: Some theoretical and conceptual problems in Revelle et al. *Journal of Experimental Psychology: General*, **109**, 32-41.

F

Fabry, P., and Tepperman, J. (1970). Meal frequency - possible factor in human pathology. *American Journal of Clinical Nutrition*, **23**, 1059-1068.

Feurle, G. H., Ketterer, H. D., Becker, W., and Creutzfeldt, W. (1972). Circadian serum gastrin concentrations in control persons and in patients with ulcer disease. *Scandinavian Journal of Gastroenterology*, **7**, 177-183.

Fischer, F. M., Moreno, C. R., Fernandez, R., L., Berwerth, A., Coffani dos Santos, A. M., and Bruni, A, C. (1993). Day- and shiftworker's leisure time. *Ergonomics*, **36**, 43-49.

Fletcher, B. (1991). *Work, Stress, Disease and Life Expectancy*. Wiley: Chichester.

Folkard, S. (1975). Diurnal variation in logical reasoning. *British Journal of Psychology*, **66**, 1-8.

Folkard, S. (1979). Times of day and levels of processing. *Memory and Cognition*, **7**, 247-252.

Folkard, S. (1987). Circadian Type Inventory (Department of Psychology, University of Sheffield)

Folkard, S. (1990). Circadian performance rhythms: some practical and theoretical implications. Philosophical Transactions of the Royal Society of London B, 327, 543-553.

Folkard, S. (1993). Editorial. *Ergonomics*, **36**, 1-2.

Folkard, S. (1994). A Critique of The Health and Safety Aspects of Working Hours: A Critical Review of the Literature by J. M. Harrington. Report to the Health and safety Executive. HMSO.

Folkard, S. (1996). Effects of performance efficiency. In P. P. Colquhoun, G., Costa, S. Folkard and P. Knauth (Eds.), *Shift work: problems and solutions*. Peter Lang: Frankfurt, pp.65-88.

Folkard, S. (1997). Black Times: Temporal Determinants of Transport Safety. *Accident Analysis And Prevention*, **29**, 417-430.

Folkard, S. (1998). Time Awareness Questionnaire. Personal Communication. Department of Psychology, University of Wales Swansea.

Folkard, S., Arendt, J., and Clark, M. (1991). Sleep and mood on a "weekly" rotating (7-7-7) shift system: some preliminary results. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.), *Shiftwork: Health, Sleep, and Performance*. Peter Lang: Frankfurt, pp.484-489.

Folkard, S. and Barton, J. (1993). Does the 'forbidden zone' for sleep onset influence morning shift sleep duration? *Ergonomics*, **36**, 85-91.

Folkard, S., and Condon, R. (1987). Night shift paralysis in air traffic control officers. *Ergonomics*, **30**, 1353-1363.

Folkard, S., and Hill, J. (2000). Shiftwork and Accidents. In T. Marek, H, Oginska, J. Pokorski, G. Costa, and S. Folkard (Eds.), *Shiftwork 2000: Implications for science, practise and* *business*. Jagiellonian University: Chair of managerial Psychology and Ergonomics, Institute of Management, pp. 11-28.

Folkard, S., and Hill, J. (2001). Working Hours and Risk. Paper presented at Proceedings of Thematic Session on Working Hours. The 10th European Congress on Work and Organisational Psychology, 16-19 May, 2001. Kraków, Prague, pp. 126.

Folkard, S., and Hill, J. (2001). Can we predict perceived risk? Paper presented at the XVth International Symposium on Night and Shiftwork, 10-13 September, 2001. Hayama, Japan.

Folkard, S., and Hunt, L. J. (2000). Morningness-eveningness and long-term shiftwork tolerance. In S. Hornberger, P. Knauth, G. Costa and S. Folkard (Eds.). *Shiftwork in the 21st century: challenges for research and practice*. Peter Lang: Frankfurt, Berlin, Bern, New York, Paris and Vienna.

Folkard, S., Knauth, P., Monk, T. H. and Rutenfranz, J. (1976). The effect of memory load of the circadian variation in performance efficiency under a rapidly rotating shift system. *Ergonomics*, **19**, 479-488.

Folkard, S., Minors, D. S., and Waterhouse, J. M. (1985). Chronobiology and Shift Work: Current Issues and Trends. *Chronobiologia*, **12**, 31-54.

Folkard, S., and Monk, T. H. (1980). Circadian rhythms in human memory. *British Journal of Psychology*, **71**, 295-307.

Folkard, S., and Monk, T. H. (1981). Individual differences in the circadian response to a weekly rotating shift system. In A. Reinberg, N, Vieux, and P. Andlauer (Eds.), *Night and Shiftwork: Biological and Social Aspects*. Pergamon Press: Oxford, pp. 367-374.

Folkard, S., & Monk, T. H. (Eds.). (1985). *Hours of work: Temporal factors in work scheduling*. New York: Wiley.

Folkard, S., Monk, T. H., Bradbury, R., and Rosenthal, J. (1977). Time of day effects in school children's immediate and delayed recall of meaningful material. *British Journal of Psychology*, **68**, 45-60.

Folkard, S., Monk, T. H., and Lobban, M. C. (1978). Short- and long-term adjustment of circadian rhythms in 'permanent' night nurses. *Ergonomics*, **21**, 785-799.

Folkard, S., Monk, T. H., and Lobban, M. C. (1979). Towards a predictive test of adjustment to shiftwork. *Ergonomics*, **22**, 79-91.

Folkard, S., Smith, L., Macdonald, I., and Tucker, P. (1997). The impact of features of shift systems on health and performance. Report for the Health and Safety Executive.

Folkard, S., and Totterdell, P. (1991). Circadian variations in performance. Implications for abnormal work hours. Paper presented at the International Symposium on Shiftwork and Job Demands, Paris, France, 11-12 July 1991.

Folkard, S., Totterdell, P., Minors, D., and Waterhouse, J. (1993). Dissecting circadian performance rhythms: implications for shiftwork. *Ergonomics*, **36**, 283-288.

Folkman, S., and Lazarus, R. S. (1980). An analysis of coping in a middle-aged community sample. *Journal of Health and Social Behaviour*, **21**, 219-239.

Ford, D., and Kamerov, D. (1989). *Journal of the American Medical Association*, **262**, 1479-1484.

Foret, J., and Benoit, O. (1974). Structure du sommeil chez des travailleurs a horaires alternants. *Electroencephalography and Clinical Neurophysiology*, **37**, 337-374.

Foret, J., and Benoit, O. (1978). Shiftwork: the level of adjustment to schedule reversal assessed by a sleep study. *Waking and Sleeping*, **2**, 107-112.

Foret, J., and Benoit, O. (1980). Predictable Effects on Individual Sleep Patterns During a Rapidly Rotating Shift System. *International Archives of Occupational and Environmental Health*, **45**, 49-56.

Foret, J., Bensimon, G., Benoit, O., and Vieux, N. (1981). Quality of sleep as a function of age and shift work. In A. Reinberg, N. Vieux and P. Andlauer (Eds.) *Night and Shift Work: Biological and Social Aspects*. Pergamon Press: Oxford, pp.149-154.

Foret, J., and Lantin, G. (1972). The Sleep of Train Drivers: An Example of the Effects of Irregular Work Schedules on Sleep. In W. P. Colquhoun (Ed.), *Aspects of Human Efficiency*. English Universities Press: London.

Fortier, I., Marcoux, S., and Brisson, J. (1995). Maternal work during pregnancy and the risks of delivering a small-for-gestational-age or preterm infant. *Scandinavian Journal of Environment and Health*, **21**, 412-418.

Fox, A. J., and Collier, P. F. (1976). Low mortality rates in industrial cohort studies due to selection for work and survival in industry. *British Journal of Preventive and Social Medicine*, **30**, 225-230.

Frank, E., Kupfer, D. J., Ehlers, C. L., Monk, T. H. and Cornes, C. (1995). Interpersonal and social rhythm therapy for bipolar disorder: integrating interpersonal and behavioural approaches. *Behaviour Therapist*, **17**, 144-149.

Frankenhauser, M. (1975). Sympathetic-adrenomedullary activity behaviour and the psychosocial environment. In P. H. Venables and M. J. Christie (Eds.), *Research in psychophysiology*. Wiley: New York, pp. 71-94.

Freeman, G., and Hovland, C. (1934). Diurnal variations in performance and related physiological functions. *Psychological Bulletin*, **31**, 777-799.

Friedman, G. D., Siegalaub, A. B., and Seltzer, C. C. (1974). Cigarettes, alcohol, coffee, and peptic ulcer. *New England Journal of Medicine*, **290**, 469-473.

Frese, M., and Semmer, N. (1986). Shiftwork, stress, and psychosomatic complaints: A comparison between workers in different shiftwork schedules, non-shiftworkers and former shiftworkers. *Ergonomics*, **29**, 99-114.

Freud, S. (1930). *Civilization and its Discontents*. Hogarth Press: London.

Frienkel, N., Mager, M., and Vinnick, L. (1968). Cyclicity in the inter-relationships between plasma insulin and glucose during starvation in normal young men. *Journal of Laboratory and Clinical Medicine*, **71**,171-178.

Fröberg, J. (1977). Twenty-four hour patterns in human performance, subjective and physiological variables and differences between morning and evening active subjects. *Biological Psychology*, **5**, 119-134.

Fröberg, J. (1981). Shiftwork and irregular working hours in Sweden: research issues and methodological problems. In L. C. Johnson, D. I. Tepas, W. P. Colquhoun and M. J. Colligan (Eds.). *The Twenty-Four Hour Workday: Proceedings of a Symposium on Variations in Work-Sleep Schedules* (US Department of Health and Human Services).

Fukuda, K. (1997). Twins under shift work: a case study of sleep log data, *Perception and Motor Skills*, **84**, 931-937.

Funk, S. C. (1992). Hardiness: A Review of Theory and Research. *Health Psychology*, **11**, 335-345.

Furnham, A. (1986). Economic locus of control. *Human Relations*, **39**, 29-43.

G

Gadbois, C. (1981). Women on night shift: interdependence of sleep and off-the-job activities. In Reinberg, A., Vieux, N., and Andlauer, P. (Eds.). *Night and shift work: Biological and social aspects*. Pergamon Press: Oxford, pp. 223-227.

Gangopadhyay, A., Chandrawanshi, A., and Pati, A. K. (1989). Assessment of pulmonary function in young and elderly shift workers of a steel plant. *Biological Rhythm Research*, **29**, 272-285.

Ganguli, P. C., and Forrester, J. M. (1972). Circadian rhythm in plasma level of gastrin. *Nature*, **236**, 127-128.

Ganster, G., Fusilier, M. R., and Mayes, B. T. (1986). Role of social support in experience of stress at work. *Journal of Applied Psychology*, **71**, 102-110.

Gardell, B., Baneryd, K., Gobrii, B., and Lundqvist, L. (1968). Arbetsupplevelse av könsrollewr. Report No. 55, PA-rådet, Stockholm.

Garland, F. (1990). Geographic variation in breast cancer mortality in the US: A hypothesis involving exposure to solar radiation. *Preventive Medicine*, **19**, 614-622.

Gaulthier, M., Housset, P., and Martin, E. (1961). Enquete sur les trouble observes en milieu industriel. *Arch. Mal. Prof.*, **22**, 129-134.

Gersten, A. H. (1987). Adaptation in rotating shift worker: A six year follow up study. Unpublished doctoral dissertation. Illinois Institute of Technology: Chicago.

Gillberg, M. (1984). The effects of two alternative timings of a one-hour nap on early morning performance. *Biological Psychology*, **19**, 45-54.

Gillberg, M. (1985). Effects of naps on performance. In S. Folkard and T. H. Monk (Eds.), *Hours of Work: Temporal Factors in Work Scheduling*. John Wiley and Sons: Chichester, pp.67-75.

Gillberg, M. (1998). Subjective alertness and sleep quality in connection with permanent 12-hour day and night shifts. *Scandinavian Journal of Work Environment and Health*, **24**, 76-81.

Gillberg, M., and Åkerstedt, T. (1981b). Possible measures of 'sleepiness' for the evaluation of disturbed and displaced sleep. In A. Reinberg, N. Vieux and P. Andlauer (Eds.), *Night and Shift Work: Biological and Social Aspects*. Pergamon Press: Oxford, pp.155-160.

Gillberg, M., and Åkerstedt, T., (1982a). Temperature and sleep at different time of the day. *Sleep*, **5**, 378-388.

Gillberg, M., and Åkerstedt, T., (1982b). The circadian pattern of unrestricted sleep and its relation to body temperature, hormones and alertness. In L.C Johnson, D. I. Tepas, W. P. Colquhoun and M. J. Colligan (Eds.), *Biological Rhythms, Sleep and Shift Work*. Spectrum Medical and Scientific Books: New York, pp.481-498.

Gillberg, M., Kecklund, G., Axelsson, J., and Åkerstedt, T.(1994). Counteracting sleepiness with a short nap. *Journal of Sleep Research*, **3**, 90.

Gillin, J. C. (1983). The sleep therapies of depression. *Progress in Neuropsychopharmacology and Biological Psychiatry*, **7**, 351-364.

Gillin, J. C. (1985). Sleep and Dreams. In G. L., Klerman, M. M., Weismann, P. S., Applebaum and L. H. Roth (Eds.), Psychiatry (Volume 3). Lippincott: Philadelphia.

G.M.B. (2002). Shiftwork. www.gmb.org.uk

Goldberg, D. P. (1972). *The Detection of Psychiatric Illness by Questionnaire*. Oxford University Press: Oxford.

Gomes, A. A., Silva, C. F., Clemente, V., Ferreira, A. M., Coelho, I., Cesar, H., Pissarra, C., and de Azevedo, M. H. P. (1999). Reliability and factor analysis of the time awareness questionnaire (Portuguese version). *Vigilia-Sueño*, **11**, 105-110.

Gordon, N. P., Clearly, P. D., Parker, C. E., and Czeisler, C. A. (1986). Sleeping pill use, heavy drinking and other unhealthful practices and consequences associated with shiftwork. A national probability sample study. *Sleep Research*, **14**, 94.

Green, K. L., and Johnson, J. V. (1990). The effects of psychosocial work organisation on patterns of cigarette smoking among male chemical-plant employees. *American Journal of Public Health*, **80**, 1368-1371.

Green, S. B. (1991). How many subjects does it take to do a regression analysis? *Multivariate Behavioural Research*, **26**, 449-510.

Greenwood, K. M., Rich, W. J., and James, J. E. (1995). Sleep hygiene practices and sleep duration in rotating-shift shiftworkers. *Work and Stress*, **9**, 262-271.

Grzech-Sukalo, H., Hedden, I., and Nachreiner, F. (1990). The relation of periodic components and psychosocial impairment for selected shift rota. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.), *Shiftwork: Health, Sleep, and Performance*. Peter Lang: Frankfurt, pp.191-196.

Grzech-Sukalo, H., and Nachreiner, F. (1997). Structural Properties of Shift Schedules, Employment of Partners, and Their Effects on Worker's' Family and Leisure Activities. *International Journal of Occupational and Environmental Health*, **3**, 67-70.

H

Hackman, J. R., and Oldham, G. R. (1975). Development of the Job Diagnostic Survey. *Journal of Applied Psychology*, **60**, 159-170.

Haider, M., Cervinka, R., Koller, M., and Kundi, M. (1988). A destabilisation theory of shiftwork effects. In W. T. J. M. Hekkens, G. A. Kerkhof and W. J. Riewelt (Eds.), *Trends in Chronobiology*. Pergamon Press: Oxford, pp.195-207.

Haimov, I., and Lavie, P. (1997). Circadian characteristics of sleep propensity function in healthy elderly: A comparison with young adults. *Sleep*, **20**, 294-300.

Hakkinen, S. (1969). Adaptability to shift work. In A. Swensson (Ed.). Proceedings of an International Symposium, Oslo, pp.68-80.

Halberg, F. (1989). Chronobiology, Radiobiology and Steps toward the timing of cancer radiotherapy. In A. L. Goldston (Ed.), *Cancer Management in Man: Detection, Diagnosis, Surgery, Radiology, Chronobiology, Endocrine Therapy*. Kluwer Academic Publishers: Dordrecht, pp.227-253.

Hamelin, P. (1987). Lorry driver's time habits in work and their involvement in traffic accidents. *Ergonomics*, **30**, 1323-1333.

Hammen, C. (1988). Self-cognitions, stressful events, and the prediction of depression in children of depressed mothers. *Journal of Abnormal Child Psychology*, **16**, 347-367.

Handijex, Sv. (1990). Study on Coronary Risk Factors and Metabolic Diseases among Shift and Night Transport Workers. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.), *Shiftwork: Health, Sleep, and Performance*. Peter Lang: Frankfurt, pp.376-379.

Hanecke, K., Tiedemann, S., Nachreiner, F., and Grzech-Sukalo, H. (1998). Accident risk as a function of hour at work and time of day as determined from accident data and exposure models for the German working population. *Scandinavian Journal of Work and Environmental Health*, **24**, 43-48.

Harburg, E., Schull, W. J., Erfurt, J. C., and Schork, M. A. (1970). A family set method for estimating heredity and stress I: A pilot survey of blood pressure among negroes in high and low stress areas, Detroit, 1966-1967. *Journal of Chronic Disease*, **23**, 69-81.

Härmä, M. (1993). Individual differences in tolerance to shiftwork: a review. *Ergonomics*, **36**, 101-109.

Härmä, M., Hakola, T., Åkerstedt, T., and Laitinen, J. (1994). Age and adjustment to night work. *Occupational and Environmental Medicine*, **51**, 568-573.

Härmä, M., Knauth, P. and Illmarinen, J. (1989). Daytime napping and its effects on alertness and short term memory performance in shiftworkers. *International Archives of Occupational and Environmental Health*, **61**, 341-345.

Härmä, M., Tenkanen, L., Sjoblom, T., Alikoski, T., and Heinsalmi, P. (1998). Combined effects of shift work and life-style on the prevalence of insomnia, sleep deprivation and daytime sleepiness. *Scandinavian Journal of Work Environment and Health*, **24**, 300-307.

Harrington, J. M. (1978). Shift work and health: A critical review of the literature. HMSO: London.

Harrington, J. M. (1993). The health and safety aspects of working hours: A critical Review of the Literature. Institute of Occupational Health: University of Birmingham, August 1993.

Harrington, R. (1994). Affective disorders. In M. Rutter, E. Taylor and L. Hersov (Eds.), *Child and adolescent psychiatry*. Blackwell: Oxford, pp.330-350.

Harris, M. M. (1989). Reconsidering the employment interview: A review of recent literature and suggestions for future research. *Personnel Psychology*, **42**, 691-726.

Havlik, R. J., and Feinlab, M. (1979). Proceedings of the conference on the decline in coronary heart disease mortality. NHI Publications: Washington, pp. 1610-1625.

Hay, D. R., and Foster, F. H. (1981). The influence of race, religion, occupation and other social factors on cigarette smoking in New Zealand. *International Journal of Epidemiology*, **10**, 41-43.

Health and Safety at Work Act. (1974), UK Parliament, HMSO.

Healy, D., Minors, D. S., and Waterhouse, J. M. (1993). Shiftwork, helplessness and depression. *Journal of Affective Disorders*, **29**, 17-25.

Hedden, I., Grzech-Sukalo, H., and Nachreiner, F. (1990). Classification of shift rotas on the basis of periodic components. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.), *Shiftwork: Health, Sleep, and Performance*. Peter Lang: Frankfurt, pp.197-202.

Heppner, P. P., Reeder, B. L., and Larson, L. M. (1983). Cognitive variables associated with personal problem-solving appraisal: Implications for counselling. *Journal of Counselling Psychology*, **30**, 537-545.

Herbert, A.(1983). The influence of shift work on leisure activities: A study with repeated measurement. *Ergonomics*, **26**, 565-574.

Hildebrandt, G. (1986). Individual differences in susceptibility to night- and shift work. Proceedings of the VIIth International Symposium on Night- and Shift Work, Inglis, Austria.

Hildebrandt, G., and Stratmann, I. (1979). Circadian system response to night work in relation to individual circadian phase position. *International Archives of Occupational and Environmental Health*, **43**, 73-83.

Hill, J. M. M., and Trist, E. L. (1955). Changes in accidents and absences in length of service. *Human Relations*, **8**, 121-152.

Hollmann, S., Heuer, H., and Schmidt, K. (2001). Control at work: a generalized resource factor for the prevention of musculoskeletal symptoms? *Work & Stress*, **15**, 29-39.

Holmes, T. H. and Rahe, R. H. (1967). The Social Readjustment Rating Scale. *Journal of Psychosomatic Research*, **11**, 213-218.

Horne, J. A., and Östberg, O. (1976). A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. *International Journal of Chronobiology*, **4**, 97-110.

Hornberger, S., and Knauth, P., P. (1995). Effects of various types of change in shift schedules: a controlled longitudinal study. *Work and Stress*, **9**, 124-133.

Hornberger, S., and Knauth, P., P. (1998). Follow-up intervention study on effects of a change in shift schedule on shiftworkers in the chemical industry. *International Journal of Industrial Ergonomics*, **21**, 249-257.

Horne, J. A., and Östberg, O. (1977). Individual differences in human circadian rhythms. *Biological Psychology*, **5**, 179-190.

Horne, J. A., and Reyner, L. A. (1995). Driver sleepiness. *Journal of Sleep Research*, **4**, 23-29.

House, J. S., Strecher, V. J., Metzner, H. L., and Robbins, C. A. (1986). Occupational stress and health among men and women in the Tecumseh Community Health Study. *Journal of Health and Social Behaviour,* **27**, 62-77.

Hrushesky, W. (1989). Circadian Chronotherapy: From Animal Experiments to Human Cancer Chemotherapy. In B. Lemmer (Ed.), *Chronopharmacology: cellular and Biochemical Interactions*. Marcel Dekker: New York, pp.439-473.

Hume, K. I., and Mills, J. N. (1977). Rhythms of REM and slow wave sleep in subjects living on abnormal time schedules. *Waking and Sleeping*, **3**, 291-296.

Humm, C. (1996). The relationship between night duty tolerance and personality. *Nursing Standard*, **51**, 34-39.

I

ILO (International Labour Office) (1990). The hours we work: new work schedules in policy and practise. *Conditions of Work Digest*, **9**, no. 2, pp. 258. (ILO, Geneva).

Infante-Rivard, C., David, M., Gauthier, R., and Rivard, G. E. (1993). Pregnancy loss and work schedule during pregnancy. *Epidemiology*, **4**, 73-75.

Institute for Circadian Physiology (1990). The Economic Impact of Human Maladaptation to Round-The-Clock Operations (White paper).

Ishihara, K., Miyasita, A., Inugami, M., Fakuda, K., Yamasaki, K., and Miyata, Y. (1985). Differences in time or frequency of meals, alcohol and caffeine ingestion, and smoking found between morning and evening types. *Psychological Reports*, **57**, 391-396.

Ishihara, K., Miyake, S., and Miyata, Y. (1992). Morningness-eveningness preference and sleep habits in Japanese office workers of different ages. *Chronobiologia*, **19**, 9-16.

Ishihara, K., Miyasita, A., Inugami, M., Fakuda, K., Yamasaki, K., and Miyata, Y. (1986). The results of investigation of the Japanese version of morningness-eveningness questionnaire. *Japanese Journal of Psychology*, **57**, 87-91.

Iskra-Golec, I. (1993). The relationship between circadian, personality and temperament characteristics and attitude towards shiftwork. *Ergonomics*, **36**, 149-153.

Iskra-Golec, I., Marek, T., and Noworol, C. (1995). Interactive effect of individual factors on nurses health and sleep. *Work and Stress*, **9**, 256-261.

Iskra-Golec, I., and Pokorski, J. (1990). Sleep and health complaints in shiftworking women with different temperament and circadian characteristics. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.). *Shiftwork, Health, Sleep and Performance*. Peter Lang: Frankfurt.

J

Jackson, S. E., Zedeck, S., and Summers, E. (1985). Family life disruptions: effects of job-induced structural and emotional interference. *Academic Management Journal*, **28**, 574-586.

Jacquis, H. (1963). Travail poste et fatigue. *Arch. Mal. Prof.*, **24**, 193-196.

Jamal, M., and Jamal, S. (1982). Work and nonwork experiences of employees on fixed and rotating shifts: an empirical assessment. *Journal of Vocational Behaviour*, **20**, 282-293.

Jansen, B. (1987). Dagdienst en ploegendiest in vergelijkend perspectief [Daywork and shiftwork compared], Swets and Zeitlinger: Lisse.

Jauhar, P., and Weller, M. P. I. (1982). Psychiatric morbidity and time zone changes: a study of patients from Heathrow Airport. *British Journal of Psychiatry*, **140**, 231-235.

Jenkins, C. D. (1976). Recent evidence supporting psychologic and social risk factors in coronary disease. *New England Journal of Medicine*, **294**, 987-994.

Johnson, J., Weissman, M. M., and Klerman, G. L. (1992). Service utilisation and social morbidity associated with depressive symptoms in the community. *Journal of the American Medical Association*, **267**, 1478-1483.

Jozef, D. (1990). Morbidity and Absenteeism rates of operators connected with duration of shift In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.), *Shiftwork: Health, Sleep, and Performance*. Peter Lang: Frankfurt, pp.283-287.

Judge, T. A. (1993). Does Affective Disposition Moderate the Relationship Between Job Satisfaction and Voluntary Turnover? *Journal of Applied Psychology*, **78**, 395-401.

Judge, T. A., and Watanabe, S. (1994) Individual differences in the nature of the relationship between job and life satisfaction. *Journal of Occupational and Organizational Psychology*, **67**, 101-107.

Jugel, M., Spangenberg, B., and Stollberg, R. (1978). *Schichtarbeit und Lebensweise*. Dietze-Verlag: Berlin.

K

Kaliterna, L., Vidacek, S., Radosevic-Vidacek, B. (1988). Concurrent validity of circadian type questionnaires for psychometric complaints and quality of sleep in shiftworkers. Proceedings of the 4th meeting of the European Society for Chronobiology.

Kaliterna, L., Vidacek, S., Radosevic-Vidacek, B., and Prizmic, Z. (1993). The reliability and stability of various individual difference and tolerance to shiftwork measures. *Ergonomics*, **36**, 183-190.

Kandolin, I. (1993). Burnout of female and male nurses in shiftwork. *Ergonomics*, **36**, 141-147.

Kandolin, I., and Kauppinen-Toropainen, K. (1990). The psychosocial aspects of women's shiftwork. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.). *Shiftwork, Health, Sleep and Performance*. Peter Lang: Frankfurt.

Kany, S., and Bentall, R. P. (1989). Persecutory delusions and attributional style. *British Journal of Medical Psychology*, **61**, 191-198.

Kaplan, M. N. (1978). Stress, the sympathetic nervous system and hypertension. *Journal of Human Stress*, **4**, 29-34.

Karasek, R. A. (1979). Job demands, job decision latitude and mental strain: Implications for job redesign. *Administrative Science Quarterly*, **24**, 285-307.

Kasl, S. V. (1973) Mental health and work environment. An examination of the evidence. *Journal of Occupational Medicine*, **15**, 506-15

Keys, A. (1967). Epidemiological studies related to coronary heart disease. Characteristic of men aged 40-59 in Seven countries. *Acta Medica Scandinavia*, **460**, 1.

Kerkhof, G. A. (1984). A Dutch-language questionnaire for the selection of morning and evening type individuals (in Dutch). *Nederlands Tijdschrift voor de Psychologie*, **39**, 281-294.

Kerkhof, G. A. (1985a). Inter-individual differences in the human circadian system: A review. *Biological Psychology*, **20**, 83-112.

Kerkhof, G. A. (1985b). Individual differences in circadian rhythms. In Folkard, S. and Monk, T. H. (Eds.). *Hours of Work: Temporal factors in work scheduling*. Wiley: New York, pp.29-35.

Kiesswetter, E. (1993). A polysomnographic study of morning and afternoon sleep quality during simulated night shift work. *Ergonomics*, **36**, 265-272.

Kiesswetter, E., Seeber, A., Golka, K., and Sietmann, B. (1997). Solvent Exposure, Shiftwork, and Sleep. *International Journal of Occupational and Environmental Health*, **3**, 61-66.

Kinderman, P., and Bentall, R. P. (1996). A new measure of causal locus: the internal, personal and situational attributions questionnaire. *Personality and Individual Differences*, **20**, 261-264.

Kirkcaldy, B., and Cooper, C. L. (1992). Work attitudes and leisure preferences: Sex differences. *Personality and Individual Differences*, **13**, 329-334.

Kirkcaldy, B. D., and Redgrove, J. (1991). The impact of gender on the relationship between occupational and recreational interests. *Sportwissenschaft*, **21**, 62-69.

Kirscht, J. P. (1972). Perceptions of control and health beliefs. *Canadian Journal of Behavioural Science/Review of Canadian Science Compendium*, **4**, 225-237.

Kleitman, N. (1963). *Sleep and Wakefulness*. University of Chicago Press: Chicago.

Kleiven, M., Bøggild, M. and Jeppesen, H. J. (1998). Shift work and sick leave. *Scandinavian Journal of Work Environment and Health*, **24**, 128-133.

Klevecz, R. R., and Barly, P. S. (1987). Circadian and Ultradian Rhythms of Proliferation in Human Ovarian Cancer. *Chronobiology International*, **4**, 513-523.

Knauth, P. (1983). Ergonomische Beitrage zu Sicherheitsaspekten der Arbeitszeitorgnaisation. Forschr-Ber. VDI-Z, Nr. 18.

Knauth, P. (1998). Innovative worktime arrangements. *Scandinavian Journal of Work Environment and Health*, **24**, 13-17.

Knauth, P. (1993). The design of shift systems. *Ergonomics*, **36**, 15-28.

Knauth, P., and Kiesswetter, E. (1987). A change from weekly to quicker shift rotations: a field study of discontinuous three-shift workers. *Ergonomics*, **30**, 1311-1321.

Knauth, P., Kiesswetter, E., Bruder, S., Romberg, H. P., and Rutenfranz, J., J. (1980). Day Sleep during the Morning and during the Afternoon between Experimental Night Shifts. 5th European Congress on Sleep Research, Amsterdam, 1980, 198-202.

Knauth, P., Kiesswetter, E. and Rutenfranz, J. (1981). Rhythem im Leben. In Die Psychologie des 20. Jahrhundrets. Kindler-Verlag: Zurich, 680-713.

Knauth, P., Landau, K., Dröge, C., Schwitteck, M., Widynski, M., and Rutenfranz, J. (1980). Duration of Sleep Depending on the Type of Shift Work. *International Archives of Occupational and Environmental Health*, **46**, 167-177.

Knauth, P. and Rutenfranz, J., (1972). Untersuchgen zum Problem des Sclafverhaltens bei experimenteller Scichtarbeit. *International Archives Arbeitsmed*, **30**, 1-22.

Knauth, P. and Rutenfranz, J. (1975). The effects of noise on the sleep of night-workers. In P. Colquhoun, S. Folkard, P. Knauth and J. Rutenfranz (Eds.), *Experimental Studies of Shift Work*. Westdeutscher Verlag: Opladen, pp.57-65.

Knauth, P. and Rutenfranz, J. (1976). Experimental shift work studies of permanent night and rapidly rotating shift systems. *International Archives of Occupational and Environmental Health*, **37**, 125-137.

Knauth, P. and Rutenfranz, J. (1981). Duration of Sleep Related to the Type of Shift Work. In A. Reinberg, N. Vieux and P. Andlauer (Eds.) *Night and Shift Work: Biological and Social Aspects*. Pergamon Press: Oxford, pp.161-168.

Knauth, P. and Rutenfranz, J. (1982). Development of criteria for the design of shiftwork systems. *Journal of Human Ergology*, **11**, 337-367.

Knauth, P. and Schmidt, K. H. (1985). Bescleunigung der Schichtrotation und Ausweitung der regulraren Betriebszeit auf das Wochenende. Eine Feldstudie bei Dreishictarbeittern. Z.Arb.wiss, 39, 226-230.

Knight, A. (1995). *Long Hours Culture*. Austin Knight: London.

Knutsson, A., and Åkerstedt, T. (1990). Shift work and health – a model of disease mechanism. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.), *Shiftwork: Health, Sleep, and Performance*. Peter Lang: Frankfurt, pp.380-385.

Knutsson, A., and Åkerstedt, T. (1992). The healthy-worker effect: self-selection among Swedish shift workers. *Work and Stress*, **6**, 163-167.

Knutsson, A., Åkerstedt, T. and Jonsson, B. G. (1988). Prevalence of risk factors for coronary artery disease among day and shift workers. *Scandinavian Journal Of Work Environment And Health*, **14**, 317-321.

Knutsson, A., Åkerstedt, T., Jonsson, B., and Orth-Gomer, K. (1986). Increased risk of ischaemic heart disease in shiftworkers. *Lancet*, **12**, 89-92.

Knutsson, A., and Nilsson, T. (1997). Job Strain in Shift and Daytime Workers. *International Journal of Occupational Environmental Health*, **3**, 79-81.

Kogi, K. (1976). Effects of industrialisation on working schedules. *Journal of Human Ergology*, **5**, 133-143.

Kogi, K. (1985). Introduction to the problems of shiftwork. In S. Folkard and T. H. Monk (Eds.), *Hours of Work – Temporal Factors in Work Scheduling*. John Wiley: New York, pp. 165-184.

Kogi, K. (1990). Women and night work: An introduction. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.). *Shiftwork, Health, Sleep and Performance*. Peter Lang: Frankfurt.

Kogi, K., Miura, T., and Saito, H. (1982). Shiftwork: its practise and improvement. Proceedings of the Sixth International Symposium on Night and Shift Work. *Journal of Human Ergology*, **11**, Supplement, 1982.

Koheygi, I., and Bedi, G. (1962). Der Zusammenhang zwichen Alkoholgenß und Unfallen im ungarischen Kohlenbergbau. International Archives Gewerbepath Gewerbehygiene (west Berlin), 19, 87-99.

Koller, M. (1983). Health risks related to shift work. *International Archives of Occupational and Environmental Health*, **53**, 59-75.

Koller, M., Kundi, M., and Cervinka, R. (1978). Field studies of shiftwork and an Austrian oil refinery I: Health and psychosocial well-being of shiftworkers who drop out of shiftwork. *Ergonomics*, **21**, 835-847.

Kolomodin-Hedman, B., and Swensson, Å. (1975). Problems related to shift work. A filed study of Swedish railroad workers with irregular work hours. *Scandinavian Journal of Work Environment and Health*, **1**, 254-262.

Kripke, D. F., Simons, R. N., Garfinkel, L., and Hammond, E. C. (1979). Short and long sleep and sleeping pills. *Archives of General Psychiatry*, **36**, 103-116.

Kristensen, T. (1989). Cardiovascular disease and the work environment: a critical review of the epidemiologic literature on nonchemical factors. *Scandinavian Journal Of Work Environment And Health*, **15**, 165-179.

Kundi, M. (1986). Long term adaptation to shift work. In M. Haider, M. Koller and R. Cervinka (Eds.), *Night and shift work: Long term effects and their prevention*. Peter Lang: Frankfurt, pp.59-65.

Kupfer, D. (1976). REM Latency: A psychobiologic marker for primary depressive disease. *Biological Psychiatry*, **11**, 159-174.

Kurumatani, N., Koda, S., and Nakariri, S. (1994). The effects of frequently rotating shiftwork on sleep and the family life of hospital nurses. *Ergonomics*, **37**, 995-1007.

L

Lack, L. C., and Lushington, K. (1996). The Rhythms of Human Sleep Propensity and Core Body Temperature. *Journal of Sleep Research*, **5**, 1-11.

Lai,, C. S. (1994). Sickness absence in a Singapore refinery. *Ann Acad Med Singapore*, **5**, 660-664.

Lamberg, L. (1994). *Bodyrhythms: chronobiology and peak performance*. William Morrow and Company: New York.

Larsen, R. J. (1985). Individual differences in circadian activity rhythm and personality. *Personality and Individual Differences*, **6**, 305-311.

Latham, G. P. and Saari, L. M. (1984). Do people do what they say? Further studies on the situational interview. *Journal of Applied Psychology*, **69**, 569-573.

Lavie, P. (1986). Ultrashort sleep-waking schedule. III. 'Gates' and 'forbidden zones' for sleep. *Electroencephalography and Clinical Neurophysiology*, **63**, 414-424.

Lavie, P. (1989). To nap – perchance to sleep – ultradian aspect of napping. In D. F. Dinges and R. J. Broughton (Eds.), *Sleep and alertness: Chronobiological behavioural and medical aspects of napping*. Raven Press: New York, pp.99-119.

Lavie, P. (1991). The 24-hour sleep propensity function (SPF). In T. H. Monk (Ed.), Sleep, *Sleepiness and Performance*. Wiley: Chichester, pp.65-93.

Lavie, P., Chillag, N., Epstein, R., Tzinschinsky, O., Givon, R., Fuchs, S., and Shahal, B. (1989). Sleep disturbances in shift-workers: a marker for maladaptation syndrome. *Work and Stress*, **3**, 33-40.

Lavie, P., and Segal, S. (1989). Twenty-four-hour structure of sleepiness in morning and evening persons investigated by ultrashort sleep wake cycle. *Sleep*, **12**, 522-528.

Lawler, K. A., and Schmeid, L. A. (1992). A prospective study of womens health – the effects of stress, hardiness, locus of control, type-A behaviour and physiological reactivity. *Women and Health*, **19**, 27-41.

Lazarus, R., and Folkman, S. (1984). *Stress, appraisal and coping*. Springer: New York.

Lee, K. A. (1992). Self-Reported Sleep Disturbances in Employed Women. *Sleep*, **15**, 493-498.

Lee, S. H., and Cho, K. S. (1982). Shift work and coalmine accidents in Korea. In K. Kogi, T. Miura and H. Saito (Eds.), Shiftwork: Its practise and improvement. Proceedings of the Sixth International Symposium on Night and Shift Work. *Journal of Human Ergology*, **11**, Supplement. Centre for Academic Publications Japan: Tokyo, pp.87-92.

Lennernäs, A. C., Andersson, A., and Hambræs, L. (1990). Nutrient intake and dietary patterns among male shiftworkers in Sweden. In G. Costa, C. Cesana, K. Kogi and A. Wedderburn (Eds.). *Studies in Industrial and Organisational Psychology*. Proceedings of the IX International Symposium on Night and Shiftwork. Peter Lang: Frankfurt, pp.386-391.

Lennernäs, M. A. C., Hambræs, L., and Åkerstedt, T. (1993). Nutrition and shiftwork: the use of meal classification as a new tool for qualitative/quantitative evaluation of dietary intake in shiftworkers. *Ergonomics*, **36**, 247-254.

Lennernäs, M. A. C., Hambræs, L., and Åkerstedt, T. (1994). Nutrient intake in day workers and shift workers. *Work and Stress*, **8**, 332-342.

Leonard, R. (1980). Night- and shift-work. In A. Reinberg, N. Vieux and P. Andlauer. *Night and Shift Work: Biological and Social Aspects*. Pergamon Press: Oxford, pp. 323-329.

Leuliet, S. (1963). Douze annees de travail poste 3 X 8. *Arch. Mal. Prof.*, **24**, 164-171.

Levin, E., Kirsner, J. G., and Palmer, W. L. (1952). Effect of banthine on gastric secretion in man. *Review of Gastroenterology*, **19**, 339-350.

Levine, R. (1990). Differences in the Quality of Semen in Outdoor Workers During Summer and Winter. *New England Journal of Medicine*, **323**, 12-16.

Lieberman, H., Wurtman, J. J., and Teicher, M. (1989). Circadian rhythms of activity in health in young and elderly humans. *Neurobiology of Ageing*, **10**, 259-265.

Loudon, R. J., and Bohle, P. L. (1997). Work-Non-work Conflict and Health in Shiftwork: Relationships with Family Status and Social Support. *International Journal of Occupational and Environmental Health*, **3**, 71-77.

Lund, R. (1974). Personality factors and desynchronisation of circadian rhythms. *Psychosomatic Medicine*, **36**, 224-228.

Lyon, H. M., Kaney, S., and Bentall, R. P. (1994). The defensive function of persecutory delusions: Evidence from attribution tasks. *British Journal of Psychiatry*, **164**, 637-646.

M

Maasen, A. (1980). The family life of shift workers and the school careers of their children. In The effects of shift work on health, social and family life. European Foundation for the Improvement of Living and Working Conditions: Dublin.

Maasen, A., Meers, A., and Verhaegan, P. (1980). Quantitative and Qualitative Aspects of Sleep in Young Self-selected Four-shift Workers. *International Archives of Occupational and Environmental Health*, **45**, 81-86.

MacDonald, I., Smith, L., Lowe, S. L., and Folkard, S., S. (1997). Effects of accidents on time into shift and of short breaks between shifts. *International Journal of Occupational and Environmental Health*, **3**, 40-45.

Mahan, R. P., Carvalhais, A. B., and Queen, S. E. (1990). Sleep reduction in night-shift workers: is it sleep deprivation or a sleep disturbance disorder? *Perceptual and Motor Skills*, **70**, 723-730.

Makowiec-Dabrowska, T. (1990). Social aspects of undertaking shiftwork including night shift of women workers in Poland. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.). *Shiftwork, Health, Sleep and Performance*. Peter Lang: Frankfurt.

Malherbe, C., de Gasparo, M., de Hertogh, R., and Hoet, J. J. (1969). Circadian variations of blood sugar and plasma insulin levels in man. *Diabetologia*, **5**, 397-404.

Mamelle, N., Luamon, B., and Lazar, P. (1984). Prematurity and occupational activity during pregnancy. *American Journal of Epidemiology*, **119**, 309-322.

Mann, F. C., and Hoffman, L. R. (1960). *Automation and the Worker: A Study of Social Change in Power Plants*. New York.

Manning, M. R., Williams, R. F., and Wolfe, D. M. (1988). Hardiness and the relationship between stressors and outcomes. *Work and Stress*, **2**, 205-216.

Marmot, M. G. (1997). Contribution of job control and other risk factors to social variations in coronary heart disease incidence. *Lancet*, **350**, 1562-1565.

Marmot, M., Siegrist, J., Theorell, T., and Feeney, A. (1999). Health and psychosocial environment at work. In M. G. Marmot and R. Wilkinson (Eds.), *Social Determinants of Health*. Oxford University Press: Oxford, pp.105-131.

Marquie, J. C., and Foret, J. (1999). Sleep, age and shiftwork experience. *Journal of Sleep Research*, **8**, 297-304.

Matsumoto, K. (1978). Sleep patterns in hospital nurses due to shiftwork: An EEG study. *Waking and Sleeping*, **2**, 169-173.

Matsumoto, K., and Morita, Y. (1987). Effects of Nighttime Nap and Age on Sleep Patterns of Shift Workers. *Sleep*, **10**, 580-589.

Maurice, M. (1975). *Shift Work*. International Labour Office: Geneva.

Maury, A. (1991) Personal Communication. In Folkard, S. and Barton, J. (1993). Does the 'forbidden zone' for sleep onset influence morning shift sleep duration? *Ergonomics*, **36**, 85-91.

Maury, P., and Quéinnec, Y. (1993). Qualitative changes in recall memory during day and night shifts. *Ergonomics*, **36**, 289-297.

McDonald, A., D., McDonald, J. C., Armstrong, B., Cherry, N. M., Cote, R., and Lavoie, J. (1988). Fetal death and work in pregnancy. *British Journal of Industrial Medicine*, **45**, 148-157.

McDonald, A., D., McDonald, J. C., Armstrong, B., Cherry, N. M., Nolin, A. D., and Robert, D. (1988). Prematurity and work in pregnancy. *British Journal of Industrial Medicine*, **45**, 56-62.

McGhie, A., and Russell, S. M. (1962). The subjective assessment of normal sleep patterns. *Journal of Mental Science*, **8**, 642-654.

McGlone, G.J., and Chenoweth, I.G. (2001). Job demands and control as predictors of occupational satisfaction in general practice. *The Medical Journal of Australia*, **175**, 88-91.

McNamee, R., Binks, K., Jones, S., Faulkner, D., Slovak, A., and Cherry, N. M. (1996). Shiftwork and mortality from ischaemic heart disease. *Occupational and Environmental Medicine*, **53**, 367-373.

Meadows, D., Richardson, J., Bruckmann, G. (1982). *Groping in the Dark: the first decade of global modelling*. Wiley: New York.

Meccaci, L., and Rochetti, G. (1998). Morning and evening types: stress related personality aspects. *Personality and Individual Differences*, **25**, 537-542.

Meccaci, L., and Zani, A. (1983). Morningness-eveningness preferences and sleep-wake diary data of morning and evening types in student and worker samples. *Ergonomics*, **26**, 1147-1153.

Meccaci, L., Zani, A., Rochetti, G., and Lucioli, R. (1986). The relationship between morningness-eveningness, ageing and personality. *Personality and Individual Differences*, **6**, 911-913.

Mechanic, D. (1966). Response factors in illness: The study of illness behaviour. *Social Psychiatry*, **1**, 11-20.

Meers, A. (1977). Personal communication.

Meers, A., Maasen, A., and Verhaegen, P. (1978). Subjective health after six months and after four years of shiftwork. *Ergonomics*, **21**, 857-859.

Meijer, M., and Ng-A-Tham, J. (1990). Utility of time: Measurement and Use. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.), *Shiftwork: Health, Sleep, and Performance.* Peter Lang: Frankfurt, pp.203-207.

Mensch, B. S., and Kandel, D. B. (1988). Do job conditions influence the use of drugs? *Journal of Health and Social Behaviour*, **29**, 169-184.

Menzel, W. (1950). Zur Physiologie und Pathologie des Nacht- und Schichtarbeiters. *Arbeitphysiologie*, **14**, 304-318.

Messing, K., Saurel-Cubizolles, M. J., Bourgine, M., and Kaminski, M. (1992). Menstrual-cycle characteristics and work conditions of workers in poultry slaughterhouses and canneries. *Scandinavian Journal of Work, Environment and Health*, **18**, 302-309.

Michel-Briand, C., Chopard, J. L., Guiot, A., Paulmier, M., Struder, G., and Struder, G. (1981). The pathological consequences of shiftwork in retired workers. In A. Reinberg, A. Vieux and A. Andlauer (Eds.), *Night and Shift Work: Biological and Social Aspects*. Pergamon Press: Oxford, pp.399-406.

Middlekoop, H. A. M., SmildevandenDoel, D. A., Neven, A. K., Kamphuisen, H. A., and Springer, C. P. (1996). Subjective sleep characteristics of 1,485 males and females aged 50-93: Effects of sex and age, and factors related to self-evaluated quality of sleep. *Journals of Gerontology Series A - Biological Sciences and Medical Sciences*, **51**, 108-115.

Miles, L. E., and Dement, W. C. (1980). Sleep and ageing. *Sleep*, **3**, 119-229.

Millar, J. D. (1993). Public enlightenment and mental health in the workplace. In G. P Keita and S. L. Sauter (Eds.), *Work and Well-Being, An Agenda for the 1900's.* American Psychological Association: Washington, DC, pp.5-8.

Minors, D. S., Healy, D., and Waterhouse, J. M. 91994). The attitudes and general health of student nurses before and immediately after their first 8 weeks of nightwork, *Ergonomics*, **37**, 1355-1362.

Minors, D. S., Rabbitt, P. M. A., Worthington, H., and Waterhouse, J. M. (1989). Variation in meals and sleep-activity patterns in aged subjects: Its relevance to circadian rhythm studies. *Chronobiology International*, **6**, 139-146.

Minors, D. S., and Waterhouse, J. M. (1983). Circadian rhythm amplitude – is it related to rhythm adjustment and/or worker motivation? *Ergonomics*, **26**, 299-241.

Mitler, M. M., Carskadon, M. A., Czeisler, C. A., Dement, W. C., Dinges, D. F., and Graeber, R. C. (1988). Catastrophes, sleep and public policy. Consensus Report, *Sleep*, **11**, 100-109.

Moe, K. E., Prinz, P. N., Vitiello, M. V., Marks, A. L., and Larsen, L. H. (1990). In Tankova, I., Adan, A., and Buela-Casal, G. (1994). Circadian typology and individual differences: A review. *Personality and Individual Differences*, **16**, 671-684.

Moline, M. L., Pollak, C. P., Monk, T. H., Lester, L. S., Wagner, D. R., Zendell, S. M., Graber, R. C., Salter, C. A., and Hirsch, E. (1991). Age related differences in recovery from simulated jet lag. *Sleep*, **14**, 42-48.

Monk, T. H. (1988). Coping and the stress of shiftwork. *Work and Stress*, **2**, 169-172.

Monk, T. H. (2000). What Can the Chronobiologist Do to Help the Shift Worker? *Journal of Biological Rhythms*, **15**, 86-94.

Monk, T. H., and Aplin, L. C. (1980). Spring and autumn Daylight Saving Time changes: Studies of adjustment in sleep timings, mood, and efficiency. *Ergonomics*, **23**, 167-178.

Monk, T. H. Buysse, D. J., Reynolds, C. F., Jarrett, D. B., and Kupfer, D. J. (1992). Rhythm vs homeostatic influences on mood, activation, and performance in young and old men. *Journal of Gerontology*, **47**, 221-227.

Monk, T. H., Buysse, D. J., Reynolds, C. F., Kupfer, D. J., and Houck, P. R. (1995). Age related shiftwork intolerance: is it mediated by a change in normal temperature rhythm amplitude? *Shiftworker International Newsletter*, **12**, 41.

Monk, T. H., Buysse, D. J., Reynolds, C. F., Kupfer, D. J., and Houck, P. R. (1995). Circadian temperature rhythms of older people. *Experimental Gerontology*, **30**, 455-474.

Monk, T. H. and Folkard, S. (1985). Shiftwork and performance. In S. Folkard and T. H. Monk (Eds.), *Hours of Work – Temporal Factors in Work Scheduling*. John Wiley: New York, pp. 239-252.

Monk, T. H. and Folkard, S. (1992). *Making shift work tolerable*. Taylor and Francis: London.

Monk, T. H., Folkard, S., and Wedderburn, A. (1996). Maintaining safety and high performance on shiftwork. *Applied Ergonomics*, **27**, 17-23.

Monk, T. H., Reynolds, C. F., Buysse, D. J., and Hoch, C. C. (1991). Circadian characteristics of healthy 80-yr-olds and their relationship to objectively recorded sleep. *Journal of Gerontology*, **46**, 171-175.

Monk, T. H. and Wagner, J. A. (1989). Social factors can outweigh biological ones in determining night shift safety. *Human Factors*, **31**, 721-724.

Moog, R. (1981). Morning-evening types and shift work. A questionnaire study. In Reinberg, A., Vieux, N., and Andlauer, P. (Eds.). *Night and shift work: Biological and social aspects.* Pergamon Press: Oxford, pp. 481-488.

Moog, R. (1987). Optimisation of shift work: Physiological contributions. *Ergonomics*, **30**, 1249-1259.

Moog, R., and Hildebrandt, G. (1989). Adaptation to shift work - experimental approaches with reduced masking effects. *Chronobiology International*, **6**, 65-75.

Moore, J. G. (1973b). High gastrin acid after vagotomy and pyloroplasty in man: evidence for non-vagal mediation. *American Journal of Digestive Disorders*, **18**, 661-669.

Moore, J. G., (1988). Chronobiology of gastric function: relevance to human ulcerogenesis. In W. Th. J. M. Hekkens, G. A. Kerkhof and W. J. Rietveld (Eds.), *Trends in Chronobiology.* Pergamon Press: Oxford, pp.295-306.

Moore, J. G., and Englert, E. Jr. (1970). Circadian rhythm of gastric acid secretion in man. *Nature*, **226**, 1261-1262.

Moore, J. G., and Halberg, F. (1987). Circadian rhythm of gastric acid secretion in active duodenal ulcer: Chronobiological statistical characteristics and comparison of acid secretory and plasma gastrin patterns with healthy subjects and post-vagotomy and pylorplasty patients. *Chronobiologia International*, **4**, 101-110.

Moore, J. G., and Wolfe, M. (1973a). The relation of plasma gastrin to the circadian rhythm of gastric acid secretion in man. *Digestion*, **9**, 97-105.

Moore, J. G., Wolfe, M. E. (1974). Circadian plasma gastrin levels in feeding and fasting man. *Digestion*, **11**, 226-232.

Moore-Ede, M., and Richardson, G. (1985). Medical implications of shiftwork. *Annual Review of Medicine*, **36**, 607-617.

Mott, P. E., Mann, F. C., McLoughlin, Q., and Warwick, D. P. (1965). *Shift Work. The Social, Psychological and Physical Consequences*. University of Michigan Press: Ann Arbor.

Mulder, M., Rosa, R. R., Härmä, M., and Nasman, O. (1994). The effects of two different shift schedules on the sleep of young and older shiftworkers. *Ergonomics*, **37**, 95-107.

Murrell, K. F. H. (1971). Industrial work rhythms. In W. P. Colquhoun (Ed.), *Biological Rhythms and Performance.* Academic Press: London.

N

Nachreiner, F. (1975). Role perceptions, job satisfaction and attitudes towards shiftwork of workers in different shift systems as related to situational and personal factors. In P. Colquhoun, S. Folkard, P. Knauth and J. Rutenfranz (Eds.). *Experimental studies of shiftwork.* Opladen: Westdeutscher Verlag.

Nachreiner, F. (1998). Individual and social determinants of shiftwork tolerance. *Scandinavian Journal of Work, Environment and Health*, **24**, 35-42.

Nachreiner, F., Akkerman, S., and Hanecke, K. (2000). Fatal accident risk as a function of hours into work. In S. Hornberger, P. Knauth, G. Costa and S. Folkard (Eds.), *Shiftwork in the 21st century: challenges for practise and research*. Peter Lang: Berlin.

Nachreiner, F., Baer, K., Diekmann, A., and Ernst, G. (1984). Some new approaches in the analysis of the interference of shift work with social; life. In A. A. I. Wedderburn and P. Smith (Eds.), *Psychological Approaches to night and shift work*. International research papers. Heriot Watt University, Edinburgh.

Nachreiner, F., Lübeck-Plöger, H., Grzech-Sukalo, H. (1995). Changes in the structure of health complaints as related to shiftwork exposure. *Work and Stress*, **9**, 227-234.

Nachreiner, F., and Rutenfranz, J. (1975). Sozialpsychologische, arbeitpsychologische und arbeitmedizinische Erhebungen in der Chelischen Industrie. In F. Nachreiner, R. Frielingsdorf, R. Romahn, P. Knauth, W. Kuhlmann, F. Klimmer, J. Rutenfranz., and E. Werner (Eds.), *Schichtarbeit bei kontinuierlicher Produktion*, pp. 83-177.

Naitoh, P. (1981). Circadian cycles and the restorative power of naps. In L. C. Johnson, D. I., Tepas, W. P. Colquhoun and M. J. Colligan (Eds.), *Biological Rhythms, Sleep and Shift Work*. Spectrum Medical and Scientific Books: New York: New York, pp.553-580.

Naitoh, P., Kelley, T., and Babkoff, H. (1993). Sleep inertia: best time not to wake up? *Chronobiologia International*, **10**, 109-118.

Nakano, Y., Miura, T., Hara, I., Aono, H., Miyano, N., Miyajima, K., Tabuchi, T., and Kosaka, H. (1982). The effects of shiftwork on cellular immune function. Proceedings of the 6th International Symposium on Night and Shift Work. *Journal of Human Ergology*, **11**, 131-138.

Nakata, A., Gharatani, T., Kawakami, N., Miki, A., Kurabayashi, L., and Shimizu, H. (2000). Sleep problems in white-collar male workers in an electric equipment manufacturing company in Japan. *Industrial Health*, **38**, 62-68.

Natale, V., and Adan, A. (1999). Season of birth modulates morningness-eveningness preference in humans. *Neuroscience Letters*, **274**, 139-141.

Natale, V., and Cicogna, P. (1996). Circadian regulation of subjective alertness in morning and evening types. *Personality and Individual Differences*, **20**, 491-497.

National Health Care Financing Review (1998). In Coburn, E. (1996). Shiftworker Fatigue: The $77 Billion Problem. http://www.circadian.com/shiftworker fatigue_text.htm

National Sleep Foundation (NSF)(1997). Gallup poll. National Sleep Foundation: Los Angeles.

Nebel, L. E., Howell, R. H., Krantz, D. S., Falconer, J. J., Gottdeiner, J. S., and Gabby, F. H. (1996). The circadian variation of cardiovascular stress levels and reactivity: Relationship to individual differences in morningness-eveningness. *Psychophysiology*, **33**, 273-281.

Neubauer, A. C. (1992). Psychometric comparison of two circadian rhythm questionnaires and their relationship with personality. *Personality and Individual Differences*, **13**, 125-131.

Newman, A. B., Spieckerman, C. F., Enright, P., Lefkowitz, D., Manolio, T., Reynolds, C. F., and Robbins, J. (2000). Daytime sleepiness predicts mortality and cardiovascular disease in older adults. *Journal of the American Geriatrics Society*, **48**, 115-123.

Ng-A-Tham, J. E. E., and Meijer, S. (1990). Financial compensation of the Inconveniences of Night- and Shiftwork. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.), *Shiftwork: Health, Sleep, and Performance.* Peter Lang: Frankfurt, pp.316-317.

Ng-A-Tham, J. E. E, and Thierry, H. (1993). An experimental change of the speed of rotation of the morning and evening shift. *Ergonomics*, **36**, 51-57.

Nikolova, N., Vassileva, O., Handijex, Sv., Angelova, K., and Saradjova, N. (2000). Dyslipidemias and other cardiovascular risk factors in shiftworking air-traffic controllers. In S. Hornberger, P. Knauth, G. Costa and S. Folkard (Eds.), *Shiftwork in the 21st century: challenges for practise and research.* Peter Lang: Berlin, pp.207-212.

Nilsson, C. (1981). Social consequences of the scheduling of working hours. In A. Reinberg, A. Vieux and A. Andlauer (Eds.), *Night and Shift Work: Biological and Social Aspects.* Pergamon Press: Oxford, pp.489-494.

Nurminen, T. (1989). Shift work, fetal development and course of pregnancy. *Scandinavian Journal of Environment and Health,* **15**, 395-403.

Nurminen, T. (1995). Female noise exposure, shift work, and reproduction. *Journal of Occupational and Environmental Medicine*, **37**, 945-950.

Nurminen, T. (1998). Shift work and reproductive health. *Scandinavian Journal of Work and Environmental Health,* **24**, 28-34.

O

O'Driscoll, M. P. (1996). The interface between job and off job roles: enhancement and conflict. *International Review of Industrial and Organisational Psychology*, **7**, 279-306.

Oginski, A., Kuleta, J., Pietsch, E., Oginska, H., and Pokorski, J. (1990). Daylong burden of female shiftworker. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.). *Shiftwork, Health, Sleep and Performance.* Peter Lang: Frankfurt, pp. 111-114.

Oginska, H., and Oginski, A. (1990). Sex differences in sleep behaviour of shiftworkers. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.). *Shiftwork, Health, Sleep and Performance.* Frankfurt am Main: Peter Lang.

Oginska, H., Pokorski, J., and Oginski, A. (1993). Gender, ageing and shiftwork tolerance. *Ergonomics*, **36**, 161-168.

Ognianova, V. M., Dalbokova, D. L., and Stanchev, V. (1998). Stress states, alertness and individual differences under 12-hour shiftwork. International Journal of Industrial *Ergonomics*, **21**, 283-291.

Ohayon, M. M., Caulet, M., Philip, P., Guilleminault, C., and Priest, R. G. (1997). How sleep and mental disorders are related to complaints of daytime sleepiness. *Archives of Internal Medicine*, **157**, 2645-2652.

Olsson, K., Kandolin, I., and Kauppinen-Toropainen, K. (1990). Stress and coping strategies of three-shift workers. *Le Travail Humain*, **53**, 175-188.

Ong, C. N., Phoon, W. O., Iskandar, N., and Chia, K. S. (1987). Shiftwork and work injuries in an iron and steel mill. *Applied Ergonomics*, **18**, 51-56.

Orth-Gomer, K. (1983). Intervention in coronary risk factors by adapting a shift work schedule to biological rhythmicity. *Psychosomatic Medicine*, **45**, 407-415.

Ostberg, O. (1973). Interindividual differences in the circadian and fatigue patterns of shiftworkers. *British Journal of Industrial Medicine*, **30**, 341-351.

Oswald, I. (1966). *Sleep*. Penguin Books, Ltd: Harmondsworth, Middlesex.

P

Paffenbarger, R. S., Wing, A. L., and Hyde, R. T. (1974). Coffee, cigarettes and peptic ulcer. *New England Journal of Medicine*, **290**, 1091.

Park, Y. M., Matsumoto, K., Seo, Y. J., Shinkoda, H., and Park, K. P. (1998). Sleep in relation to age, sex and chronotype in Japanese workers. *Perceptual and Motor Skills*, **87**, 199-215.

Parkes, K. (1982). Personality and coping as moderators of work stress processes – models, methods and measures. *Work and Stress*, **8**, 110-129.

Patkai, P. (1971a). The diurnal rhythms of adrenaline secretion in subjects with different working habits. *Acta Psychologica Scandinavia*, **81**, 30-34.

Patkai, P. (1971b). Interindividual differences in diurnal variations in alertness, performance, and adrenaline excretion. *Acta Psychologica Scandinava*, **81**, 35-46.

Patkai, P., and Dahlgren, K. (1981). Satisfaction with different types of rapidly rotating shift systems. In A. Reinberg, N. Vieux and P. Andlauer (Eds.), *Night and Shiftwork: Biological and Social Aspects*. Pergamon Press: Oxford, pp. 245-250.

Pavalco, M. M., Elder, P., and Clipp, J. (1993). *The Working Environment*. Wiley: New York.

Peacock, B., Glube, R., Miller, M., and Clune, P. (1983). Police officer's responses to 8 and 12 hour shift schedules. *Ergonomics*, **26**, 479-493.

Pearlin, L. I., and Schooler, C. (1978). The structure of coping. *Journal of Health and Social Behaviour*, **19**, 2-21.

Peter, R., Alfredsson, L., Knutsson, A., Siegrist, J., and Westerholm, P. (1999). Does a stressful psychosocial work environment mediate the effects of shift work on cardiovascular risk factors? *Scandinavian Journal of Work Environment and Health*, **25**, 376-381.

Pettersen, N. (1985). Specific vs generalised locus of control scales related to job satisfaction. *Psychological Reports*, **56**, 60-62.

Pierach, A., and Heynemann, K. (1955). Das Ulcusleiden der Fahr- und Schichtarbeiter mit besonderer Berucksichtigung des Eisenbahnpersonals. Der Arztl. Dienst b. d. Deutschen Bundesbahn, 1, 2-8.

Pilcher, J. J., Lambert, B. J., and Huffcutt, A. I. (2000). Differential Effects of Permanent and Rotating Shifts on Self-Report Sleep Length: A Meta-Analytic Review. *Sleep*, **23**, 155-163.

Pisarski, A., Bohle, P., and Callan, V. J. (1998). Effects of coping strategies, social support and work-nonwork conflict on shift worker's health. *Scandinavian Journal of Work Environment and Health*, **24**, 141-145.

Pitsopoulos, C., N., and Greenwood, K.M. (2002). Problems with the measures of gastrointestinal and cardiovascular symptom frequency in the Standard Shiftwork Index. *Work and Stress*, **16**, 70-78.

Pocock, S. J., Sergean, R., and Taylor, P. (1972). Absence and continuous three-shift workers. *Occupational Psychology*, **46**, 7-13.

Pokorny, M. L. I., Blom, D. H. J., and van Leeuwen, P. (1981). Analysis of traffic accident data (from bus drivers) – An alternative approach. In A. Reinberg, N. Vieux and P. Andlauer (Eds.) *Night and Shift Work: Biological and Social Aspects*. Pergamon Press: Oxford, pp.271-285.

Pokorski, J., Iskra-Golec, I., Czekaj, A. M., and Noworol, C. (1990). Menstrual rhythm and shiftwork interference – a subjective retrospective study. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.). *Shiftwork, Health, Sleep and Performance*. Peter Lang: Frankfurt.

Poole, C. J. M., Wright, A. D., and Nattrass, M. (1992). Control of diabetes mellitus in shift workers. *British Journal of Industrial Medicine*, **49**, 513-515.

Posey, T. B., and Ford, J. A. (1981). The morningness-eveningness preference of college students as measured by the Horne and Östberg questionnaire. *International Journal of Chronobiology*, **7**, 141-144.

Potter, J., and Wetherell, M. (1987). *Discourse and Social Psychology: Beyond Attitudes and Behaviour*. Sage: London.

Pradham, S. M. (1969). Reaction of workers on night shift. Proceedings of the XVI International Congress on Occupational Health, Tokyo.

Presser, H. B. (1990). The growing service economy: implications for the employment of women at night. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.). *Shiftwork, Health, Sleep and Performance.* Peter Lang: Frankfurt.

Prizmić, Z., Vidaček, S., Radoševic-Vidaček, B., Kaliterna, L., Čabrajec-Grbac, S., Lalić, V., and Fornazar-Knežević (1995). Shiftwork tolerance and 24-h variations in moods. *Work and Stress*, **9**, 327-334.

Ptacek, J. T., Smith, R. E., and Dodge, K. L. (1994). Gender differences in coping with stress: when stressor and appraisal do not differ. *Journal of Personality and Social Psychology*, **20**, 421-430.

Ptacek, J. T., Smith, R. E., and Zana, J. (1992). Gender, appraisal, and coping: A longitudinal analysis. *Journal of Personality*, **60**, 747-770.

Putilov, A. A. (1993b). Toward the enlarged version of the sleep-wake pattern assessment questionnaire. In *1993 European Meeting of Psychometric Society* (Barcelona, Spain), pp. 130.

Putilov, A. A. (2000). Association of the circadian phase with two morningness-eveningness scales of an enlarged version of the sleep-wake pattern assessment questionnaire. In S. Hornberger, P. Knauth, G. Costa and S. Folkard (Eds.). *Shiftwork in the 21st century: challenges for research and practice.* Peter Lang: Frankfurt.

Q

Quaas, N., and Tunsch, R. (1972). Problems of disablement and accident frequency in shift and night work. In A. Swensson (Ed.), Proceedings of the 2nd International Symposium on Night and Shift Work. Studia Laboris et Salutis, 11, 53-57.

R

Rafferty, Y., Fiend, R., and Landisbergis, P. A. (2001). The association between job skill discretion, decision authority and burnout. *Work & Stress*, **15**, 73-85.

Rafnsson, V., and Gunnarsdóttir, H. (1990). Mortality study of fertiliser manufacturers in Iceland. *British Journal of Industrial Medicine*, **47**, 721-725.

Rahe, R. H., Bennett, L., Romo, M., Siltanen, P., and Arthur, R. J. (1973). Subjects' recent life changes and coronary heart disease in Finland. *American Journal of Psychiatry*, **130**, 1222-1226.

Regestein, Q. R., and Monk, T. H. (1991). Is the Poor Sleep of Shift Workers a Disorder? *American Journal of Psychiatry*, **148**, 1487-1493.

Reilly, T., Waterhouse, J., and Atkinson, G. (1997). Aging, rhythms of physical performance, and adjustment to changes in the sleep-activity cycle. *Occupational and Environmental Medicine*, **54**, 812-816.

Reinberg, A. (1979). Circadian and circannual rhythms in healthy adults. In Sleep Wakefulness and Circadian Rhythm. AGARD Lecture Series No. 105, 1, 15-27.

Reinberg, A. (1983). Clinical Chronopharmacology: An Experimental Basis for Chronotherapy. In A. Reinberg and M. Smolensky (Eds.), *Biological Rhythms and Medicine.* Springer-Verlag: New York, pp.1-21.

Reinberg, A., Andlauer, P., De Prins, J., Malbecq, W., Vieux, N., and Bourdeleau, P. (1984). Desynchronisation of the oral temperature circadian rhythm and intolerance to shift work. *Nature*, **308**, 272-274.

Reinberg, A., Andlauer, P., Guillet, P., Nicolai, A., Vieux, N., and Laporte, A. (1980). Oral temperature, circadian rhythm amplitude, ageing and tolerance to shiftwork. *Ergonomics*, **23**, 55-64.

Reinberg, A., Andlauer, P., and Vieux, N. (1981a). Circadian temperature rhythm amplitude and long term tolerance of shiftworking. In *Biological Rhythms, Sleep and Shift Work.* Lancaster: MTP, pp. 61-74.

Reinberg, A., Chaumont, A. J., and Laporte, A. (1975). Circadian temporal structure of 20 shift workers (8-hour shift-weekly rotation): An autometric field study. In W. P. Colquhoun, S. Folkard, P. Knauth and J. Rutenfranz (Eds.), *Experimental Studies of Shiftwork.* Forschungberichte des Landes NRW Nr. 2513, Westdeutscher Verlag: Opladen, pp.142-165.

Reinberg, A., Motohashi, Y., Bourdeleau, P., Touitou, Y., Nouguier, J., Nouguier, J., Levi., F., and Nicolai, A. (1989). Internal desynchronisation of circadian rhythms and tolerance of shift work. *Chronobiologia*, **16**, 21-34.

Reinberg, A., Vieux, N., and Andlauer, P. (Eds.)(1981b). *Night and Shift Work: Biological and Social Aspects*. Oxford: Pergamon Press.

Reinberg, A., Vieux, N., Andlauer, P., Guillet, P, and Nicolai, A. (1981c). Tolerance of shift work, amplitude of circadian rhythms and ageing. In A. Reinberg, N. Vieux, and P. Andlauer (Eds.). *Night and Shift Work: Biological and Social Aspects*. Pergamon Press: Oxford, pp. 341-354.

Repetti, R. L. (1989). Effects of daily workload on subsequent behaviour during marital interaction: the roles of social withdrawal and spouse support. *Journal of Personality and Social Psychology*, **57**, 651-659.

Repetti, R. L. (1989). Daily job stress and father-child interaction. Paper presented at the biennial meeting of the Society for Research in Child Development, Kansas City.

Repetti, R. L. (1993b). Short-term effects of occupational stressors on daily mood and health complaints. *Health Psychology*, **12**, 125-131.

Revelle, W., Humphreys, M. S., Simon, L., and Gilliland, K. (1980). The interactive effect of personality, time of day, and caffeine: a test of the arousal model. *Journal of Experimental Psychology: General*, **109**, 1-31.

Revicki, D. A., and May, H. J. (1985). Occupational stress. Social support and depression. *Health Psychology*, **4**, 61-77.

Rieman, D., Konig, A., Hohagen, F., Kieman, A., Voderholzer, U., Backhaus, J., Bunz, J., Wesiack, B., Hermle, L., and Berger, M. (1999). How to preserve the antidepressive effect of sleep deprivation: A comparison of sleep phase advance and sleep phase delay. *European Archives of Psychiatry and Clinical Neuroscience*, **249**, 231-237.

Roberts, L. J., and Ho, R. (1996). Development of an Australian Health Locus of Control Scale. *Personality and Individual Differences*, **20**, 629-639.

Robins, C. J., and Hayes, A. H. (1995). The role of causal attributions in the prediction of depression. In G. M. Buchanan and M. E. P. Seligman (Eds.). *Explanatory style*. Hillsdale, NJ: Lawrence Erlbaum.

Robson, R., and Wedderburn, A. (1990). Women's shiftwork and their domestic commitments. In . In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.), *Shiftwork: Health, Sleep, and Performance*. Peter Lang: Frankfurt, pp.137-143.

Romon, M., Graibaud, M. H., Nuttens, M. C., Fievet, C., Bar, J. M., Pot, Ph., and Furon, D. (1990). Plasma lipids and shift work. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.), *Shiftwork: Health, Sleep, and Performance*. Peter Lang: Frankfurt, pp.399-404.

Rosa, R. R., and Bonnett, M. H. (1993). Performance and alertness on 8h and 12h rotating shifts at a natural gas utility. *Ergonomics*, **36**, 1177-1193.

Rosario, M., Shinn, M., Morch, H., and Huckabee, C. B. (1988). Gender differences in coping and social supports: testing socialisation and role constraint theories. *Journal of Community Psychology*, **16**, 55-69.

Rosenthal, L. A., and Howe, M. C. (1984). Activity patterns and leisure concepts: a comparison of temporal adaptation among day versus night shift workers. *Occupational Therapy in Mental Health*, **4**, 59-78.

Rotter, J. B. (1966). Generalised expectancies for internal versus external control of reinforcement. *Psychological Monographs*, **80**, 1-28.

Royant-Perola, S., Benoit, O., and Foret, J. (1980). Diurnal variation of body temperature and 'morningness'. Proceedings of the Fifth European Sleep Congress of the European Sleep Research Society, Amsterdam (abstract).

Rubin, N. H. (1988). Chronobiology of the Gastrointestinal System. In W. Th. J. M. Hekkens, G. A. Kerkhof and W. J. Rietveld (Eds.), *Trends in Chronobiology*. Pergamon Press: Oxford, pp.307-318.

Rutenfranz, J. (1976). Arbeitmedizinische Erwartundgen an die Ergonomie. In W. P. Brenner, W. Rohmert and J. Rutenfranz (Eds.), *Ergonomische Aspekte der Arbeitmedizin*. A. W. Gentner Verlag: Stuttgart, pp.31-37.

Rutenfranz, J. (1981). Shiftwork and research issues. In L. C. Johnson, D. I. Tepas, W. P Colquhoun and M. J. Colligan (Eds.), The 24-Hour Work Day. A symposium on Variations in Work-Sleep Schedules. National Institute for Occupational Safety and Health: Washington DC.

Rutenfranz, J. (1982). Occupational health measures for night- and shiftworkers. Proceedings of the 6th International Symposium on Night and Shift Work. *Journal of Human Ergology*, **11**, Supplement, pp.67-86.

Rutenfranz, J., Colquhoun, W. P., Knauth, P. and Ghata, J. N. (1977). Biomedical and psychosocial aspects of shift work. *Scandinavian Journal of Work Environment and Health*, **3**, 165-182.

Rutenfranz, J., Haider, M., and Koller, M. (1985). Occupational health measures for night workers and shiftworkers. In S. Folkard and T. H. Monk (Eds.), *Hours of Work: Temporal Factors in Work Scheduling*. Pergamon Press: Oxford, pp.199-210.

Rutenfranz, J., Knauth, P. and Angersbach, D. (1981). Shiftwork research issues. In L. C. Johnson, D. I. Tepas, W. P. Colquhoun and M. J. Colligan (Eds.), *Biological Rhythms, sleep and shiftwork*. Spectrum Medical and Scientific Books: New York, pp.165-195

Rutenfranz, J., Knauth, P., Küpper, R., Romahn, R., and Ernst, G. (1980). Pilot study on physiological and psychological consequences of shiftwork in some branches of the public services. In The Effects of Shiftwork on Health, Social and Family Life European Foundation for the Improvement of Living and Working Conditions: Dublin.

Rutenfranz, J., and Werner, E. (1975). Schichtarbeit bei kontiuierlicher gen bei Schichtarbeit. Arbeitsmedizin, Socialmedizin, *Praventivmedizin*, **15**, 32-40.

Rutter, M. (1990). Commentary: some focus and process considerations regarding the effects of parental depression on children. *Developmental Psychology*, **26**, 60-67.

S

Sarason, I. G., Sarason, B. R., Shearin, E. N., and Pearce, G. R. (1987). A brief measure of social support: Practical and theoretical implications. *Journal of Social and Personal Relationships*, **4**, 497-510.

Scherrer, J. (1981). Man's work and circadian rhythm through the ages. In A. Reinberg, N. Vieux, and P. Andlauer (Eds.), *Night and Shiftwork: Biological and Social Aspects*. Pergamon Press: Oxford, pp. 1-10.

Scherschlicht, R., Polc, P., Schneeberger, J., Steiner, M., and Haefely, W. (1982). Selective suppression of rapid eye movement sleep (REMS) in cats by typical and atypical antidepressants. In E. Costa and G. Racagni (Eds.), *Typical and Atypical Antidepressants: Molecular Mechanisms.* Raven Press: New York.

Schmeider, R. A., and Smith, C. A. (1996). Moderating effects of social support in shiftworking and non-shiftworking nurses. *Work and Stress*, **10**, 128-140.

Schmitt, N. (1976). Social and situational determinants of interview decisions: Implications for the employment interview. *Personnel Psychology*, **29**, 79-101.

Schneider, W., and Shiffrin, R. M. (1977). Controlled and autonomic human information processing I: detection, search, and attention. *Psychological Review*, **84**, 1-66.

Schreurs, P. J. G., and Taris, T. W. (1998). Construct validity of the demand-control model: A double cross-validation approach. *Work & Stress*, **12**, 64-84.

Schwartz, G. E., Davidson, R. J., and Goleman, D. J. (1987). Patterning of cognitive and somatic processes in the self regulation of anxiety: effects of meditation versus exercise. *Psychosomatic Medicine*, **40**, 321-328.

Scott, A. J., and Landau, J. (1990). Shiftwork: effects on sleep and health with recommendations for medical surveillance and screening. In A. J. Scott (Ed.), Occupational Medicine: State of the art reviews – Shiftwork, Volume 5, Number 2. Hanley and Belfus: Philadelphia.

Scott, A. J., Monk, T. H., and Brink, L. L. (1997). Shiftwork as a risk factor for depression: A pilot study. *International Journal of occupational and Environmental Health*, **3**, 2-9.

Scott, K. D., and Taylor, G. S. (1985). An examination of conflicting findings on the relationship between job satisfaction and absenteeism: A meta-analysis. *Academy of Management Journal*, **28**, 599-612.

Segawa, K., Nakazawa, S., Tsukamoto, Y., Kurita, Y., Goto, Y., Fukui, A., and Takano, K. (1987). peptic ulcer is prevalent among shiftworkers. *Digestive Diseases and Sciences*, **32**, 449-453.

Sekaran, U. (1985). The paths to mental health: an explanatory study of husbands and wives in dual-career families. *Journal of Occupational Psychology*, **58**, 129-137.

Sergean, R. (1971). *Managing Shiftwork.* Gower Press, Industrial Society: London.

Sergean, R., and Brierley, J. (1968). Absence and attendance under non-continuous three shift systems of work. *Nature*, **219**, 536.

Shamir, B. (1983). Some antecedents of work-nonwork conflict. *Journal of Vocational Behaviour*, **23**, 98-111.

Shapiro, A. P. (1978). Behavioural and environmental aspects of hypertension. *Journal of Human Stress*, **4**, 9-17.

Siegrist, J., Peter, R., Junge, A., Cremer, P., and Seidel, D. (1990). Low status control, high effort at work and ischaemic heart disease: Prospective evidence from blue-collar men. *Social Science Medicine*, **31**, 1127-34

Silvero, J., Silva, C., and Azedevo, M. (1997). Shiftwork, health and individual differences: the Portuguese version of the Circadian Type Inventory (CTI). *Shiftwork International Newsletter*, **14**, 89.

Singer, G., and Levens, M. (1990). Gender and personality as variables in coping with shiftwork. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.). *Shiftwork, Health, Sleep and Performance*. Peter Lang: Frankfurt, pp. 143-146.

Skipper, J. K. Jr., Jung, F. D., and Coffey, L. C. (1990). Nurses and shiftwork: effects on physical health and mental depression. *Journal of Advanced Nursing*, **15**, 835-842.

Smith, C. S., Reilly, C., and Midkiff, K. (1989). Evaluation of three circadian rhythm questionnaires with suggestions for an improved measure of morningness. *Journal of Applied Psychology*, **74**, 728-738.

Smith, C. S., Robie, C., Folkard, S., Barton, J., Macdonald, I., Smith, L. Spelten, E., Totterdell, P., and Costa, G. (1999). A Process Model of Shiftwork and Health. *Journal of Occupational Health Psychology*, **4**, 207-218.

Smith, J. A. (1995). Semi-structures interviewing and qualitative analysis. In J. A. Smith, R. Warre and L. V. Langentave (Eds.), *Rethinking methods in Psychology*. Sage: London, pp. 9-26.

Smith, J. A. (1996). Beyond the divide between cognition and discourse: using interpretative phenomenological analysis in health psychology. *Psychology and Health*, **11**, 261-271.

Smith, L., and Folkard, S., S. (1993). The perceptions and feelings of shiftworkers' partners. *Ergonomics*, **36**, 299-305.

Smith, L., and Folkard, S., S. (1993). The impact of shiftwork on personnel at a nuclear power plant: an explanatory survey study. *Work and Stress*, **7**, 341-350.

Smith, L., Folkard, S., S., and Poole, C. J. M. (1994). Increased injuries on night shift. *Lancet*, **344**, 1137-1139.

Smith, L., Macdonald, I., Folkard, S., and Tucker, P. (1998). Industrial shift systems. *Applied Ergonomics*, **29**, 273-280.

Smith, L., Totterdell, P., and Folkard, S., S. (1995). Shiftwork effects in nuclear power workers: a field study using portable computers. *Work and Stress*, **9**, 235-244.

Smith, L., Spelten, E., and Norman, P. (1995). Shiftwork locus of control: scale development, *Work and Stress*, **9**, 219-226.

Smith, M. J., Colligan, M. J., and Tasto, D. L. (1982). Health and safety consequences of shift work in the food processing industry. *Ergonomics*, **2**, 133-144.

Smith, P. A., Brown, D. F., Di Milia, L., and Wragg, C. (1993). The use of the Circadian Type Inventory as a measure of the circadian constructs of vigour and rigidity. *Ergonomics*, **36**, 169-175.

Smith, P. A., and Wilson, M. (1991). The effects of naps during night duty on the performance and mood of female nurses working in an intensive care unit. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.), *Shiftwork: Health, Sleep, and Performance*. Peter Lang: Frankfurt, pp.147-152.

Smith, P. A., Wright, B. M., Mackey, R. W., Mislop, H. W., and Yates, S. C. (1998). Change from slowly rotating 8-hour shifts to rapidly rotating 8-hour and 12-hour shifts using participative shift roster design. *Scandinavian Journal of Work Environment and Health*, **24**, 550-561.

Spector, P. (1982). Behaviour in organisations as a function of employees locus of control. *Psychological Bulletin*, **91**, 482-497.

Spector, P. E. (1986). Perceived control by employees: A meta-analysis of studies concerning autonomy and participation at work. *Human Relations*, **39**, 1005-1016.

Spector, P. (1988). Development of the Work Locus of Control scale. *Journal of Occupational Psychology*, **61**, 335-340.

Spector, P. E., and O'Connell, B. J. (1994). The contribution of personality traits, negative affectivity, locus of control and Type A to the subsequent reports of job stressors and job strains. *Journal of Occupational and Organizational Psychology*, **67**, 1-11.

Spelten, E., Totterdell, P., Barton, J., and Folkard, S. (1995). Effects of age and domestic commitments on the sleep and alertness of female shiftworkers. *Work and Stress*, **9**, 165-175.

Spiegel, K., Leproult, R., Van Cauter, E. (1999). Impact of sleep debt on metabolic and endocrine function. *Lancet*, **354**, 1435-1439.

Staines, G. L., and Pleck, J. H. (1984). Nonstandard work schedules and family life. *Journal of Applied Psychology*, **69**, 315-323.

Staw, B. M., Bell, N. E., and Clausen, J. A. (1986). The dispositional approach to job attitudes: A lifetime longitudinal test. *Administrative Science Quarterly*, **31**, 56-77.

Steenland, K., and Fine, L. (1996). Shift work, shift change, and risk of death from heart disease at work. *American Journal of Industrial Medicine*, **29**, 278-281.

Stewart, P., Rice, C., Beatty, P., Wilson, B., Stewart, W., and Blair, A. (2002). A Qualitative Evaluation of Questions and Responses from Five Occupational Questionnaires Developed to Assess Exposures. *Applied Occupational and Environmental Hygiene*, **17**, 444-453.

Strickland, B. R. (1978). Internal-external expectancies and health-related behaviours. *Journal of Consulting and Clinical Psychology*, **46**, 1192-1211.

Strogatz, S. H., Kronauer, R. E., and Czeisler, C. A. (1987). Circadian pacemaker interferes with sleep onset at specific times each day: role in insomnia. *American Journal of Physiology*, **253**, 172-178.

Sweeney, P. Anderson, K., and Bailey, S. (1996). Attributional style and depression: A meta-analytic review. *Journal of Personality and Social Psychology*, **50**, 774-791.

T

Tabachnick, B. G., and Fidell, L. S. (2001). *Using Multivariate Statistics.* Harper and Row: New York.

Tai, T. H., Scheving, L. E., and Pauly, J. E. (1982). Circadian variation in host susceptibility to Mercury Chloride and Paraquat in balb/cann female mice. In R. Takahashi, F. Halberg and C. A. Walker (Eds.), *Towards Chronopharmacology*. Pergamon Press: New York, pp.249-255.

Taillard, J., Philip, P., and Bioulac, B. (1999). Morningness/eveningness and the need for sleep. *Journal of Sleep Research*, **8**, 291-295.

Takagi, K. (1972). Influence of shift work on time and frequency of meal taking. *Journal of Human Ergology*, **1**, 195-205.

Tamarkin, L., Almeida, O. F., and Danforth, D. N. Jr. (1985). Melatonin and malignant disease. *Ciba Found Symp*, **117**, 284-299.

Tankova, I., Adan, A., and Buela-Casal, G. (1994). Circadian typology and individual differences: A review. *Personality and Individual Differences*, **16**, 671-684.

Tasto, D. L., Colligan, M. J., Skjei, E., and Polly, S. (1978). *Health Consequences of Shiftwork.* (NIOSH, Behavioural and Motivational Factors Branch, Cincinnati, Ohio).

Taub, J. M., and Berger, R. J. (1973). Sleep stage patterns associated with acute shifts in the sleep-wakefulness cycle. *Electroencephalography and Clinical Neurophysiology*, **35**, 613-619.

Taylor, E., Briner, R. B., and Folkard, S. (1997). Model of Shiftwork and Health: An Examination of the Influence of Stress on Shiftwork theory. *Human Factors*, **39**, 67-82.

Taylor, E., Folkard, S. and Shapiro, D. A. (1997). Shiftwork Advantages as Predictors of Health. *International Journal of Occupational and Environmental Health*, **3**, 20-29.

Taub, J. M., Tanguay, P. E., and Rosa, R. R. (1977). Effects of afternoon naps on physiological variables performance and self reported activation. *Biological Psychology*, **5**, 191-210.

Taylor, P. J. (1967). Shift and day work: A comparison of sickness absence, lateness, and other absence behaviour in an oil refinery from 1962 to 1965. *British Journal of Industrial Medicine*, **24**, 93-102.

Taylor, P. J. (1973). The effects upon health of shift workers. *Industrial Medicine and Surgery*, **42**, 13-20.

Taylor, P. J., Pocock, S. J. (1972). Mortality of shift and day workers 1956-68. *British Journal of Industrial Medicine*, **29**, 201-207.

Taylor, P. J., Pocock, S. J. and Sergean, R. (1972). Absenteeism of shift day workers. A study of six types of shift system in 29 organisations. *British Journal of Industrial Medicine*, **29**, 208-213.

Tepas, D. I. (1982). Adaptation to Shiftwork: Fact or Fallacy? In K. Kogi, T. Miura and H. Saito (Eds.), Shiftwork: Its practise and improvement. Proceedings of the Sixth International Symposium on Night and Shift Work. Journal of Human Ergology, 11, Supplement. Centre for Academic Publications Japan: Tokyo, pp.1-12.

Tepas, D. I. (1982a). Work/Sleep time schedules and performance. In W. Webb (Ed.), *Biological Rhythms, Sleep and Performance*. John Wiley and Sons: Chichester, pp.175-204.

Tepas, D. I. (1982b). Shiftworker sleep strategies. *Journal of Human Ergology*, **11**, 325-336.

Tepas, D. I. (1990). Do eating and drinking habits interact wit work schedule variables? *Work and Stress*, **4**, 230-211.

Tepas, D. I., Armstrong, D., Carlson, M. L., Duchon, J. C., Gersten, A., and Lezotte, D. V. (1985). Changing industry to continuous operations: different strokes for different plants. *Behaviour Research Methods, Instruments and Computers*, **17**, 670-676.

Tepas, D. I., and Carvalhais, A. B. (1990). Sleep Patterns of Shiftworkers. *Occupational Medicine: State of the Art Reviews*, **5**, 199-208.

Tepas, D. I., and Mahan, R. P. (1989). The many meanings of sleep. *Work and Stress*, **3**, 93-102.

Tepas, D. I., Walsh, J. K., and Armstrong, D. R. (1981). Comprehensive study of the sleep of shift workers. In L. C. Johnson, D. I. Tepas, W. P. Colquhoun and M. J. Colligan (Eds.), *Biological Rhythms, Sleep and Shift Work*. Spectrum Medical and Scientific Books: New York, pp.347-356.

Thelle, D. S., Forde, O. H., Try, K., and Lehmann, E. H. (1976). The Tromso heart study. *Acta Medica Scandinavia*, **200**, 107-118.

Theorell, T. (1991). Psychosocial Cardiovascular Risks – on the Double Loads in Women. *Psychotherapy and psychosomatics*, **55**, 81-89.

Theorell, T., Ahlberg-Hultén, G., Berggren, T., Perski, A., Sigala, F., Svensson J., and Wallin, B. M. (1987). Arbetsmiljo, levnadsvanor och risk for hjart-karlsjukdom. Stress Research Reports, No. 195. National Institute of Psychosocial Factors and Health.

Theorell, T., Alfredsson, L., Knox, S., Perski, A., Vensson, J. S., and Waller, D. (1984). On the interplay between socio-economic factors, personality and work environment in the pathogenesis of cardiovascular disease. *Scandinavian Journal of Work Environment and Health*, **10**, 373-380.

Thierry, Hk. (1980). Compensation for shiftwork. In W. P. Colquhoun and J. Rutenfranz (Eds.), *Studies in Shiftwork.* Taylor and Francis: London, pp.449-462.

Thierry, Hk., and Jansen, B. (1982). Social support for night and shift workers. *Journal of Human Ergology*, **11**, 483-498.

Thiis-Evensen, E. (1949). *Skiftarbeid og helse* [Shiftwork and health]. Porsgrunn [Norway]. Norsk-Hydro, Oslo.

Thiis-Evensen, E. (1956). *Skiftarbeid og helse - II* [Shiftwork and health]. Porsgrunn [Norway]. Norsk-Hydro, Oslo, 1-67.

Thiis-Evensen, E. (1958). Shiftwork and health. *Industrial Medicine and Surgery*, **27**, 493-497.

Thoits, P. A. (1986). Social support as coping assistance. *Journal of Consulting and Clinical Psychology*, **54**, 416-423.

Thorndike, E. L. (1926). *Mental Work and Fatigue and Individual Differences and their Causes*. Columbia University: New York.

Tilley, A. J., Wilkinson, R. T., and Drud, M. (1981). Night and Day shifts compared in terms of the quality and quantity of sleep recorded in the home and performance measured at work: A pilot study. In A. Reinberg, N. Vieux and P. Andlauer (Eds.) *Night and Shift Work: Biological and Social Aspects*. Pergamon Press: Oxford, pp.187-196.

Tilley, A. J., Wilkinson, R. T., Warren, P. S. G., Watson, B., and Drud, M. (1982). The Sleep and Performance of Shift Workers. *Human Factors*, **24**, 629-641.

Tobin, D. L., Holroyd, K. A., Reynolds, R. V., and Wigal, J. K. (1989). The hierarchical factor structure of the Coping Strategies Inventory. *Cognitive Therapy and Research*, **13**, 343-361.

Torsvall, L., and Åkerstedt, T. (1980). A diurnal type scale. *Scandinavian Journal of Work and Environmental Health*, **6**, 283-290.

Torsvall, L., Åkerstedt, T. and Gillberg, M. (1981). Age, sleep and irregular workhours. A field study with electroencephalographic recordings, catecholamine excretion and self-ratings. *Scandinavian Journal of Work Environment and Health*, **7**, 196-203.

Torsvall, L., Åkerstedt, T., Gillander, K., and Knutsson, A. (1989). Sleep on the Night Shift: 24-Hour EEG Monitoring of Spontaneous Sleep/Wake Behaviour. *Psychophysiology*, **26**, 352-358.

Torsvall, L., Castenfors, K., Åkerstedt, T. and Fröberg, J. (1987). Sleep at sea: a diary study of the effects of unattended machinery space watch duty. *Ergonomics*, **30**, 1335-1340.

Tucker, P., Barton, J., and Folkard, S. (1996). Comparison of eight and 12 hour shifts: impacts on health, wellbeing, and alertness during the shift. *Occupational and Environmental Medicine*, **53**, 767-772.

Tune, G. S. (1969). Sleep and wakefulness in a group of shiftworkers. *British Journal of Industrial Medicine*, **26**, 54-58.

U

Uehata, T., and Saskawa, N. (1982). The fatigue and maternity disturbances of night workwomen. *Journal of Human Ergology* (Tokyo), **11**, 465-474.

UK National Statistics (2001). Labour Market Spotlight October 2001.

Ulrich, L., and Trumbo, D. (1965). The selection interview since 1949. *Psychological Bulletin*, **63**, 100-116.

US Congress, Offices of Technology Assessment (1991). Biological rhythms: implications for the worker. (OTA-BA-463), US Government Printing Office: Washington DC.

V

Værnes, R. J., Knardahl, S., Rømsing, J., Aakvaag, A., Tønder, O., Walther, B., and Ursin, H. (1988). Relations between environmental problems, psychology and health among shift-workers in the Norwegian process industry. *Work and Stress*, **2**, 7-15.

Van Dongen, H. P., Kerkhof, G. A., and Kloppel, H., B. (1997). Seasonal covariation of the circadian phases of rectal temperature and slow wave sleep onset. *Journal of Sleep Research*, **6**, 19-25.

Van Dongen, H. P., Kerkhof, G. A., and Souverijn, J. H. (1998). Absence of seasonal variation in the phase of the endogenous circadian rhythm in humans. *Chronobiology International*, **15**, 623-632.

Van Gool, W. A., and Mirminan, M. (1986). Ageing and circadian rhythms. In W. A. Gool, and F. Van Harren (Eds.), *Progress in Brain Research*. Elsevier Science Publishers: New York, pp. 255-277.

Van Limborgh, C. (1995). Compensation for inconvenience: the utility of shift systems. *Work and Stress*, **9**, 342-350.

Van Loon, J. H. (1963). Diurnal Body Temperature Curves in Shift Workers. *Ergonomics*, **6**, 267-273.

Verboeket-van de Vene, W., and Westerterp, K. R. (1991). Influence of feeding frequency on nutrient utilisation in man: consequences for energy metabolism. *European Journal of Clinical Nutrition*, **45**, 161-169.

Verhaegaen, P., Cober, R., De Smedt, M., Dirkx, J., Kerstens, J., Ryvers, D., and Van Daele, P. (1987). The adaptation of night nurses to different work schedules. *Ergonomics*, **30**, 1301-1309.

Vernon, H. M. (1921). *Industrial fatigue and efficiency*. Dutton, New York.

Vernon, H. M. (1923). The causation of industrial accidents. *Journal of Industrial Hygiene*, **5**, 14-18.

Vidacek, S., Kaliterna, L., Radosevic-Vidacek, B. (1987a). Predictive validity of individual difference measures for health problems in shift workers: preliminary results. In A. Oginska, J. Pokorski, and J. Rutenfranz (Eds.), *Contemporary Advances in Shiftwork Research.* Medical Academy: Kraków, pp. 99-106.

Vidacek, S., Kaliterna, L., Radosevic-Vidacek, B., and Folkard, S. (1988). Personality differences in the phase of circadian rhythms: A comparison of morningness and extraversion. *Ergonomics*, **31**, 873-888.

Vidacek, S., Radosevik-Vidacek, B., Kaliterna, L., and Prizmic, Z. (1993). Individual differences in circadian rhythm parameters and short-term tolerance to shiftwork: a follow up study. *Ergonomics*, **36**, 117-124.

Vogel, G. W., Buffenstein, A., Minter, K., and Hennessey, A. (1990). Drug effects on REM sleep and on endogenous depression. Neuroscience and Behavioural Reviews, 14, 49-63.

Volger, A., Ernst, G., Nachreiner, F., and Hanecke, K. (1988). Common free time of family members under different shift systems. *Applied Ergonomics*, **19**, 213-218.

Voydanoff, P. (1988). Work role characteristics, family structure demands, and work/family conflict. *Journal of Marriage and Family*, **54**, 749-761.

Vroom, V. H. (1964). *Work and Motivation.* Wiley: New York.

W

Wade, L. (1955). A 'human relations' approach to sickness absenteeism and other employee problems. *Archives of Industrial Health*, **12**, 592-608.

Wagner, E. E. (1949). The employment interview: a critical summary. *Personnel Psychology*, **2**, 17-46.

Walker, J. (1985). Social problems of shiftwork. In S. Folkard and T. H. Monk (Eds.), *Hours of Work: Temporal Factors on Work Scheduling.* Wiley: New York, 165-183

Walker, J., and de la Mare, G. (1971). Absence from work in relation to length and distribution of shift hours. *British Journal of Industrial Medicine*, **28**, 36-44.

Wall, T. D., and Clegg, C. W. (1981). A longitudinal field study of group work design. *Journal of Occupational Behaviour*, **2**, 31-49.

Wall, T. D., Jackson, P. J., Mullarkey, S., and Parker, S.K. (1996). The demands-control model of job strain: A more specific test. *Journal of Occupational and Organizational Psychology*, **69**, 153-166.

Wallston, B. S., Wallston, K. A., Kaplan, G. D., and Maides, S. A. (1976). Development and validation of the Health Locus of Control (HLC) scale. *Journal of Consulting and Clinical Psychology*, **44**, 580-585.

Walsh, J. K., Muelbach, M. J., Humm, T. M., Dickens, Q.S., Sugerman, J. L., and Schweitzer, P. K. (1990). Effect of caffeine on physiological sleep tendency and ability to sustain wakefulness at night. *Psychophysiology*, **101**, 271-273.

Walsh, J. K., Tepas, D. I., and Moss, P. D. (1981). The EEG sleep of night and rotating shift workers. In L. C. Johnson, D. I. Tepas, W. P. Colquhoun and M. J. Colligan (Eds.), *Biological Rhythms, Sleep and Shift Work.* Spectrum Medical and Scientific Books: New York, pp.371-381.

Walsh, J. K., Sugerman, J. L., Muehlbach, M. J., and Schweitzer, P. K. (1987). Physiological sleep tendency during sleep-wake schedule inversion in young and middle-age adults. *Sleep Research*, **16**, 653.

Wanat, J. (1962). Accident Incidence in Various Periods in Pits. Proc. Glow. Inst. Garn. Ser A Kom 285: Poland.

Warr, P. (1983). Work, jobs and unemployment. *Bulletin of The British Psychological Society*, **36**, 305-311.

Waterhouse, J. M., Folkard, S. and Minors, D. S. (1992). Shiftwork, health and safety: An overview of the scientific literature 1978-1990. HSE Contract Research Report No. 31/1992.

Webb, W. B. (1981). Work/rest schedules: economic, health and social implications. In L. C. Johnson, D. I. Tepas, W. P. Colquhoun and M. J. Colligan (Eds.). The Twenty-Four Hour Work Day: Proceedings of a Symposium on Variations in Work-Sleep Schedules. DHSS NIOSH, Cincinnati, Ohio, pp.1-11.

Webb, W., B. (1982). Sleep in older persons: sleep structures of 50- to 60-year old men and women. *Journal of Gerontology*, **37**, 581-586.

Webb, W. B. (1983). Are there permanent effects of night shift work on sleep? *Biological Psychology*, 16, 273-283.

Webb, W. B. (1989). What is a sleep disorder? *APSS Newsletter*, **4**, 25.

Webb, W. B., and Agnew, H. W. (1967). Sleep cycling within twenty-four hour periods. *Journal of Experimental Psychology*, **74**, 158-160.

Webb, W. B., and Agnew, H. W. (1971). Stage 4 sleep: influence of time course variables. *Science*, **174**, 1354-1356.

Webb, W. B., and Agnew, H. W. Jr. (1975). Are we chronically sleep deprived? *Bulletin of the Psychonomic Society*, **6**, 47-48.

Webb, W. B., and Bonnet, M. N. (1978). The sleep of 'morning' and 'evening' types. *Biological Psychology*, **7**, 29-35.

Wedderburn, A. A. I. (1975). *Studies of shiftwork in the steel industry*. Heriot-Watt University: Edinburgh.

Wedderburn, A. A. I. (1978). Some suggestions for increasing the usefulness of psychological and sociological studies of shiftwork. *Ergonomics*, **21**, 827-833.

Wedderburn, A. A. I. (1981). How important are the social effects of shiftwork? In L. C. Johnson, D. I. Tepas, W. P. Colquhoun and M. J. Colligan (Eds.). *Biological Rhythms, Sleep and Shiftwork*. Spectrum Medical and Scientific Books: New York, pp.257-269.

Wedderburn, A. A. I. (1981). Is there a pattern in the value of time off work? In A. Reinberg, N. Vieux and P. Andlauer (Eds.), *Night and shift work: Biological and social aspects*. Pergamon Press: Oxford, pp.495-504.

Wedderburn, A. A. I. (1991). Guidelines for Shiftworkers. Bulletin of European Shiftwork Topics, No. 3. European Foundation for the Improvement of Living and Working Conditions: Dublin.

Wedderburn, A. A. I. (1991). Compensation for Shiftwork. Bulletin of the European Shiftwork Topics, no. 4. European Foundation for the Improvement of Living and Working Conditions: Dublin.

Wedderburn, A. A. I. (1995). Men and women who like continuous shiftwork are more 'hardy' but what does it mean? *Work and Stress*, **9**, 206-210.

Wedderburn, A., and Robson, M. (1990). Women who work shifts: Sturdy survivors or battle-weary Boadiceas? Paper presented at the British Association for the Advancement of Science, Swansea, August.

Wehr, T. A., Giesen, H. A., Moul, D. E., Turner, E. H., and Schwartz, P. J. (195). Suppression of men's responses to seasonal changes in day length by modern artificial lighting. *American Journal of Physiology*, **269**, 173-178.

Weidner, G., and Collins, R. L. (1993). Gender, coping and health. In H. W. Krohne (Ed.). Attention and avoidance: Strategies in coping with aversiveness. Hogrefer and Huber: Seattle, pp.241-265.

Weiner, H. (1979). *The Psychobiology of Hypertension*. Elsevier: New York.

Weitzmann, E. D., Moline, M. L., Czeisler, C. A., and Zimmerman, J. C. (1982). Chronobiology of aging, temperature, sleep/wake rhythms and entrainment. *Neurobiology of Aging*, **3**, 299-309.

Welp, E. A., Weiderpass, E., Boffetta, P., Vainio, H., Vasama-Neuvonen, K., Petralia, S and Partanen, T. J. (1998). Environmental risk factors of breast cancer. *Scandinavian Journal of Work Environment and Health*, **24**, 3-7.

Wertleib, D., Weigel, C., and Feldstein, M. (1989). Stressful experiences, temperament, and social support: impact on children's behaviour symptoms. *Journal of Applied Developmental Psychology*, **14**, 853-880.

Wever, R. A. (1965). A mathematical model for circadian rhythms. In J. Aschoff (Ed.), *Circadian Clocks.* North-Holland Publishing Co: Amsterdam, pp. 47-63.

Wever, R. (1979). *The Circadian System of Man: Results Of Experiments Under Temporal Isolation*. Springer-Verlag: Berlin.

Wever, R. A. (1980). Phase shifts of human circadian rhythms due to shifts of artificial zeitgebers. *Chronobiologia*, **7**, 303-327.

Wever, R. A. (1984a). Properties of human sleep-wake cycles: Parameters of internally synchronised freerunning rhythms. *Sleep*, **7**, 27-51.

Wever, R. A. (1984b). Sex differences in human circadian rhythms: Intrinsic periods and sleep fractions. *Experentia*, **7**, 27-51.

Wharf, H. L. (1993). Safety evaluation of working hours. Presentation by British Rail to European Railways. UIC Paris, France, 7th December, 1993.

White, R. W. (1959). Motivation reconsidered: the concept of competence. *Psychological Review*, **66**, 297-333.

WHO, World Health Organisation Study Group (1990). Diet, nutrition, and the prevention of chronic diseases. Technical Report Series, report no. 797.

Wilkinson, R., Allison, S., Feeney, M., and Kaminska, Z. (1989). Alertness of night nurses: two shift systems compared. *Ergonomics*, **32**, 281-292.

Williamson, A. M., and Sanderson, J. W. (1986). Changing the speed of shift rotation: a field study. *Ergonomics*, **29**, 1085-1096.

Wilson, G. D. (1990). Personality, time of day, and arousal. *Personality and Individual Differences*, **11**, 153-168.

Wojczak-Jaroszowa, J., Makowska, Z., Rzepecki, H., Banaszkiewicz, A., and Romejko, A. (1978). Changes in Psychomotor and Mental Task Performance Following Physical Work in Standard Conditions, and in a Shift-working Situation. *Ergonomics*, **21**, 801-809.

Wolf, St., Almy, Th. P., Bachrach, W. H., Spiro, H. M., Sturdevant, R. A. L., and Weiner, H. (1979). The role of stress in peptic ulcer disease. *Journal of Human Stress*, **5**, 27-37.

Woolf, V. (1929) *A Room of Ones Own.* 1945 Edition. Penguin: New York.

Wright, T. A., and Staw, B. M. (1999). Affect and favourable work outcomes: two longitudinal tests of the happy-productive worker thesis. *Journal of Organizational Behaviour*, **20**, 1-23.

Wyatt, S., and Marriott, R. (1953). Night work and shift changes. *British Journal of Industrial Medicine*, **10**, 164-172.

Wynne, R. F., Ryan, G. M., and Cullen, J. H. (1984). Adjustment to night work and its prediction: self-reported physical symptoms and psychological well-being. Paper presented to the XXI Congress on Occupational Health, Dublin, 9-14 September.

Wynne, R. F., Ryan, G. M., and Cullen, J. H. (1986). Adjustment to Shiftwork and Its Prediction: Results from a Longitudinal Study. In M. Haider, M. Koller and R. Cervinka

(Eds.). *Night and Shiftwork: Longterm Effects and their Prevention*. Peter Lang: Frankfurt, pp. 101-108.

XYZ

Zahorska-Markiewicz, B., Kutagowska, E., Bogunia, M., and Wegrzyn-Radecka, B. (1990). Effects of shift-work on women's well-being. In G. Costa, G. Cesana, K. Kogi and A. Wedderburn (Eds.), *Shiftwork: Health, Sleep, and Performance*. Peter Lang: Frankfurt, pp. 58-161.

Zedeck, S., Jackson, S. E., and Summers, E. (1983). Shift work schedules and their relationship to health, adaptation, satisfaction, and turnover intention. *Academy of Management Journal*, **26**, 297-310.

Appendix 1

Debriefing instructions used during the semi-structured interviews (Chapter 4)

"The interview is an informal discussion intended to help me learn more about what it's like to work on or beside the production lines, what it's like working on particular shift schedules and the problems experienced which arise directly or indirectly from these work patterns. It also provides you with the opportunity to put forward any suggestions you may have for overcoming the problems that you have highlighted.

This information will then be used to design a questionnaire to be completed by all employees working in the assembly area, the responses to which will be used to assess whether certain aspects of the shift system can be designed more appropriately. An alternative system may then be designed and piloted on the new production lines due to come into operation in the summer of 1999.

All answers will be kept confidential and only general summaries of the results will be noted and used in the development of the questionnaire. The only record of what is said within this room will be in the form of notes taken by myself throughout the discussion. The interviews are not being recorded. Names of each interviewee are recorded separately from the notes and are used merely as a means of keeping track of those who have volunteered to take part in this stage. In this way not even I will be able to attribute information back to you personally. However, quotes, taken from the notes may be used in the thesis to be written at the end of the research project. No names will be used in this write up. If you feel that you do not wish to answer any of the questions posed, please feel free to decline. This will not be held against you in any way.

Please remember that this is not a test of any sort and there are no right or wrong answers. Accordingly, you will not be judged on your responses. However, since the information will be the basis of later research please try to answer as truthfully and as fully as possible.

Are there any questions before we begin?

Are you happy to continue?"

Appendix 2

Interview Plan used during the semi-structured interviews (Chapter 4)

I. Demographic Information	❶ Name ❷ Date of Birth ❸ Job Title ❹ Job Description (e.g. monotonous, challenging, difficult, high concentration, physically demanding, mentally demanding, rewarding) ❺ Part Time or Full Time ❻ Shift System worked ❼ Length of time working for HP, length of time working for this company ❽ Previous positions in the organisation and time spent in them. ❾ Family (occupation of partner, number and ages of children)

II. Sleep Problems and Fatigue	❶ Before early/afternoon/late shift ❷ Morning shift: sleep truncated - early bedtime and risetime ❸ Between two successive shifts ❹ After shift ❺ Work day compared to rest day ❻ Feelings of tiredness and fatigue before, between, and after shift ❼ Feelings of tiredness on rest day compared to work day ❽ Leisure/family time taken up by recuperation ❾ Sleep given up in order to pursue activities with family or friends
III. Social Problems and Recreational Conflicts	❶ Problems with pursuing educational courses (e.g. college courses), sporting events, prime time TV, clubs and organisations, shopping, hobbies, religious activities ❷ Shiftwork pattern preventing preferred use of high-value hours for leisure activities ❸ Alienation from society ❹ Majority of friends inside rather than outside the workplace ❺ Difficulty 'winding down' from a shift
IV. Domestic Conflicts and Family Problems	❶ Working life lowering the quality of family life ❷ Difficulties in satisfying familial and marital roles/expectations ❸ Much of so-called recreation time taken up by domestic and/or childcare duties ❹ Work day compared to a rest day ❺ Feelings of missing out on family life ❻ Effects of work on relationship with partner ❼ Effects of work on relationship with children ❽ Level of social support

V. Eating Behaviour and Dietary Influences	❶ Diet on rest day compared to diet on work day ❷ Different eating habits on different shifts ❸ Missing of regular mealtimes: snacking, nibbling, pre-packaged foods ❹ Gastrointestinal Dysfunction ❺ Consumption of soda and caffeine on work compared to rest days ❻ Take advantage of free fruit and drinks scheme ❼ Satisfaction with canteen: opening hours, types of food and drinks on offer ❽ Weight problems caused or exacerbated by work hours
VI. Health and Well-Being	❶ Subjective feelings of effects of shiftwork on overall health ❷ Conditions arising from work schedule ❸ Exacerbation of conditions due to hours of work ❹ Irritability, nervousness, anxiety, depression, stress
VII.Coping Strategies	❶ See the negative effects of shiftwork as unavoidable ❷ Employment of coping strategies : • sleeping pills; • stimulants e.g. soda, caffeine, cigarettes; • absenteeism; • consciously set aside time for family, friends and solitary activities;
VIII. Suggestions for Overcoming the Problems	❶ Suggestions for ways of improving problems identified ❷ Specific suggestions to be taken into account in the design and implementation of the new shift systems

Appendix 3

Ranking Sheet used during the semi-structured interviews (Chapter 4)

RANKING SHEET

In the table below you will find a list of the common areas often highlighted as being problematic by shiftworkers. On the scale of 1-5, where 1 represents 'not problematic at all' and 5 represents 'extremely problematic', please rank how problematic you think each problem area is to your own situation. Please add and rate areas that you think should be included in the spaces provided.

1	2	3	4	5
Extremely Problematic	Fairly problematic	Quite problematic	Fairly unproblematic	not problematic at all

Sleep and Fatigue	1 2 3 4 5
Social and Recreational	1 2 3 4 5
Domestic and Family	1 2 3 4 5
Eating Behaviour and Diet	1 2 3 4 5
Health and Well-Being	1 2 3 4 5
	1 2 3 4 5
	1 2 3 4 5
	1 2 3 4 5
	1 2 3 4 5
	1 2 3 4 5

Given the choice, would you prefer to stay on the same shift system as you currently work or would you change it in some way?

Appendix 4

Questionnaire used amongst production line workers (Chapter 6)

SHIFTWORKER SURVEY

©

PLEASE READ CAREFULLY BEFORE PROCEEDING

The following survey is part of a wider research programme in operation at [redacted], reviewing the current shift systems and looking at the problems encountered by those who work them. The information gained will be used to assess whether certain features of the shift systems can be designed more appropriately. An alternative system may then be piloted on the new production line coming into operation at the site later this year, and will aim to decrease or ease the problems that employees may have as a direct result of their present work schedule.

Although the questionnaire is rather lengthy, in order for your participation to be of any benefit to yourself and your colleagues, it is essential that you read each question properly and answer as fully and as truthfully as possible.

Please note that any information you provide will be treated in the strictest of confidence and will not be divulged to anyone (including yourself). The research is primarily concerned with information gained from groups of shiftworkers rather than individual employees, thus no individual will be identified in connection with any of the research findings. Please also note that you have the right not to answer questions if you do not wish to do so and that you may withdraw from the study at any time.

The research project will be ongoing for the next three years, within which you will be asked to fill out several surveys. In order for responses from the same person to be matched up you will be asked to enter your birth-day and the initials of your mother or father. Thus if you were born on the 15th day of the month and your mothers name is Jane Brooks you would enter the following in the box provided on the front of all subsequent questionnaires:

15 JB

This information will be used for the sole purpose of analysing the responses. Since it is likely that some people will share the same birth-day but less likely that they would also use the same initials this code makes it virtually impossible to identify individuals but offers a good way of matching data from subsequent questionnaires.

YOUR PERSONAL CODE :	

Any questions or comments regarding the research project or the questionnaire should be addressed to:

Joanne Hill BSc (Hons)
Department of Psychology
University of Wales Swansea
Singleton Park
Swansea
SA2 8PP

e-mail: psjhill@swansea.ac.uk

1. General Biographical Information

1 Today's Date: ____ / ____ / ____

2 Age (in years): ____

3 Sex: 1 ☐ Male 2 ☐ Female

4 Area of work: ____

5 Job Title: ____

6 Are you a Permanent or Temporary employee ? 1 ☐ Permanent 2 ☐ Temporary

7 Are you full-time or part time ? 1 ☐ Full Time 2 ☐ Part Time

Your Domestic Situation

8 Are you:

1 ☐ Married/Living with partner
2 ☐ Seperated/Divorced
3 ☐ Widowed
4 ☐ Single

9 On average, how many hours per week does you partner work in paid employment ? ____ hours

10 What is your partner's usual work pattern ?

1 ☐ Daytime - no shifts
2 ☐ Rotating shifts with nights
3 ☐ Rotating shifts without nights
4 ☐ Permanent nights
5 ☐ Other: (please specify)

11 How does your partner feel about you working shifts ?

Extremely unsupportive	Fairly unsupportive	Quite indifferent	Fairly supportive	Extremely supportive
1	2	3	4	5

12 If you have children, please state their ages ☐ ☐ ☐ ☐ ☐

13 Do you have any other dependants ? If so, please state their ages ? ☐ ☐ ☐ ☐ ☐

Your Work Situation

1.14 How long have you worked altogether ? __________ years __________ months

1.15 How long have you worked at CPB ? __________ years __________ months

1.16 How long have you been working shifts ? __________ years __________ months

1.17 How long have you worked in your present shift system ? __________ years __________ months

1.18 How many hours are you contracted to work each week ? __________ hours

1.19 On average, how many hours do you work each week (excluding overtime) ? __________ hours

1.20 On average, how many hours **paid** overtime do you work each week ? __________ hours

1.21 On average, how many hours **unpaid** overtime do you work each week ? __________ hours

1.22 Do you have a second paid job in addition to your main one ? 1 ☐ Yes 2 ☐ No

1.23 If you are a Temp, how many times have you been laid off in the last 12 months ? __________ months __________ weeks

1.24 If you are a Temp, on average, how long have you been laid off at any one time ? __________ months __________ weeks

Your Shift Details

1.25 What is the maximum number of shifts of any kind you have worked between days off in the past month ? __________ shifts

1.26 If not working permanent nights, how many nights do you work per year ? *(If none, go to Question 1.28)* __________ nights

1.27 How are these nights organised ?

1 ☐ Single blocks of night duty per year

2 ☐ Occasional blocks of night duty per year

3 ☐ A block of nights each month

4 ☐ One or two nights each week

5 ☐ Other ....
(please specify)

128 Please use the symbols below to show a complete cycle of your shift including rest days. Do not use more weeks than is necessary to show how the system 'repeats itself'

E	**Early Shift**	**D**	**Day Off**
L	**Late Shift**	**O**	**Other** *(please specify)*
N	**Night Shift**		

(b) Then go back to the table and write in the start and end times of each of the shifts on each day across the week. (Please use 24h time, e.g. 21:30, or indicate "am" or "pm").

Thus for each cell within the table you should have 2 pieces of information, for example :

E 06:00-14:00

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Week 1							
Week 2							
Week 3							
Week 4							
Week 5							
Week 6							

129 Please indicate how often you:	Almost never	Rarely	Sometimes	Frequently	Almost always
(a) are required to change your roster at short notice	1	2	3	4	5
(b) swap shifts with colleagues	1	2	3	4	5
(c) make a request to work specific shifts	1	2	3	4	5
(d) are granted the request of working a specific shift	1	2	3	4	5

130 How much advance notice of your roster are you given ? ____________ weeks ____________ days

131 If you are a Temp, how much notice are you given of your employment ? ____________ weeks ____________ days

132 To what extent do you feel you have control over :	None	Not very much	A fair amount	Quite a lot	Complete
(a) the specific shifts you work	1	2	3	4	5
(b) the specific start and finish times of the shifts you work	1	2	3	4	5

Travel

1.33 How far away do you live from your place of work ? ________ miles

1.34 On average, how long does it take you to travel to and from work ?

	TO WORK	FROM WORK
Morning	________ mins	________ mins
Afternoon	________ mins	________ mins
Evening	________ mins	________ mins
Other .... *(please specify)*	________ mins	________ mins

1.35 How do you normally travel to and from work ?

	Early	Late	Night	Other
public transport	1 ☐	1 ☐	1 ☐	1 ☐
private transport: car/motorbike	2 ☐	2 ☐	2 ☐	2 ☐
private transport: bicycle	3 ☐	3 ☐	3 ☐	3 ☐
combination of public and private	4 ☐	4 ☐	4 ☐	4 ☐
company transport	5 ☐	5 ☐	5 ☐	5 ☐
by foot	6 ☐	6 ☐	6 ☐	6 ☐

1.36 Do you ever feel unsafe travelling to and from work on the following shifts ?

	Almost never	**Quite seldom**	**Quite often**	**Almost always**
Early	1	2	3	4
Late	1	2	3	4
Night	1	2	3	4
Other	1	2	3	4

2. Job Strain and Shiftwork Satisfaction

21 Use the numbers 1-5 to rate your workload in comparison to the average workload of other people performing a similar job in other parts of your organisation:

Where:
1 = Extremely light
2 = Quite light
3 = About the same
4 = Quite heavy
5 = Extremely heavy

		Early	Late	Night
(a)	Physical workload	1 ☐	1 ☐	1 ☐
(b)	Mental workload	2 ☐	2 ☐	2 ☐
(c)	Time pressures	3 ☐	3 ☐	3 ☐
(d)	Emotional stress	4 ☐	4 ☐	4 ☐

22 The statements below are to evaluate the amount of strain within your job. Please indicate the extent to which you experience each of them by circling the number you feel to be the most appropriate.

		Often	Sometimes	Rarely	Never/Almost never
(a)	My job requires me working very fast	1	2	3	4
(b)	My job requires me working very hard	1	2	3	4
(c)	I am asked to do an excessive amount of work	1	2	3	4
(d)	I have enough time to get the job done	1	2	3	4
(e)	I experience conflicting demands on my job	1	2	3	4
(f)	My job requires me to learn new things	1	2	3	4
(g)	My job requires a high level of skill	1	2	3	4
(h)	My job requires me to be creative	1	2	3	4
(i)	My job involves a lot of repetitive work	1	2	3	4
(j)	On my job I have little freedom to decide how to do my work	1	2	3	4
(k)	On my job I have little freedom to decide what to do on my work	1	2	3	4
(l)	I have the opportunity to take breaks (other than scheduled breaks) on my job	1	2	3	4

	Entirely outside of my control	Somewhat outside of my control	In between	Somewhat under my control	Entirely under my control
23 The pacing of the job I do is	1	2	3	4	5

2.4 The following questions relate to **general job satisfaction** not your satisfaction with your shift system. Please circle the appropriate answer for each question:

	Disagree strongly	Disagree	Disagree slightly	Neutral	Agree slightly	Agree	Agree strongly
Generally speaking I am very satisfied with this job	1	2	3	4	5	6	7
I frequently think of quitting this job	1	2	3	4	5	6	7
I am generally satisfied with the kind of work I do	1	2	3	4	5	6	7
Most people on this job are very satisfied	1	2	3	4	5	6	7
People on this job often think of quitting	1	2	3	4	5	6	7

2.5 Shiftwork offers a number of potential advantages for people, some of which are listed below. Please indicate, by circling a number, whether these are advantages for you:

Shiftwork:	Definitely not	Probably not	Maybe	Probably yes	Definitely yes
(a) offers higher rates of pay then daywork	1	2	3	4	5
(b) allows you to relax on your own	1	2	3	4	5
(c) frees you to pursue your hobbies	1	2	3	4	5
(d) is good for seeing tradespeople and keeping appointments	1	2	3	4	5
(e) is convenient for domestic responsibilities	1	2	3	4	5
(f) allows your partner and yourself to see each other	1	2	3	4	5
(g) allows lie-ins in the mornings	1	2	3	4	5
(h) involves a variety of work on each shift	1	2	3	4	5
(i) means you can see more of your children	1	2	3	4	5
(j) means the timetables of you and your partner co-ordinate so the children are always taken care of	1	2	3	4	5
(k) promotes a good social climate at work	1	2	3	4	5
(l) helps you to support your children's activities	1	2	3	4	5
(m) enables you to take overtime for high rates of pay	1	2	3	4	5
(n) is good for seeing friends	1	2	3	4	5
(o) gives you more responsibility at work	1	2	3	4	5
(p) increases your chances of promotion in your area of work	1	2	3	4	5
(q) allows you to have a second paid job	1	2	3	4	5

What are the 3 main **advantages** of your shift system for you ?

(1) ______________________________

(2) ______________________________

(3) ______________________________

What are the 3 main **disadvantages** of your shift system for you ?

(1) ______________________________

(2) ______________________________

(3) ______________________________

	Definitely not	**Probably not**	**Maybe**	**Probably yes**	**Definitely yes**
Do you feel that overall the advantages of your shift system outweigh the disadvantages ?	1	2	3	4	5
All things being equal, would you prefer to give up working shifts and get a day job without shifts ?	1	2	3	4	5

3. Your Sleep and Fatigue

3.1 At what time do you normally fall asleep and wake up at certain points within your shift system ? Please note the time that you normally fall asleep and wake up before, between and after the shifts that you work. Please use 24h time (e.g. 22:30) or clearly indicate "am" or "pm".

		FALL ASLEEP	WAKE UP
EARLY SHIFT			
(a)	Before your first early shift		
(b)	Between two successive early shifts		
(c)	After your last early shift		
LATE SHIFT			
(a)	Before your first late shift		
(b)	Between two successive late shifts		
(c)	After your last late shift		
NIGHT SHIFT			
(a)	Before your first night shift		
(b)	Between two successive night shifts		
(c)	After your last night shift		
DAY OFF			
(a)	Before your first day off		
(b)	Between two successive days off		
(c)	After your last day off		

3.2 If you normally take a nap/naps in addition to your main sleep, either at work or at home, at what time to you take it/ them ?

						and				
(a)	On early shifts	from		to		and	from		to	
(b)	On late shifts	from		to		and	from		to	
(c)	On night shifts	from		to		and	from		to	
(d)	On days off	from		to		and	from		to	

3.3 How many hours sleep do you feel you usually need per day, irrespective of which shift you are on ? ________ hours ________ minutes

3.4 How do you feel about the **amount** of sleep you normally get ? *(Circle one number for each)*

		Nowhere near enough	Could do with a lot more	Could do with a bit more	Get the right amount	Get plenty
(a)	Between successive early shifts	1	2	3	4	5
(b)	Between successive late shifts	1	2	3	4	5
(c)	Between successive night shifts	1	2	3	4	5
(d)	Between successive days off	1	2	3	4	5

3.5 How **well** do you normally sleep ? *(Circle one number for each)*

		Extremely badly	Quite badly	Moderately well	Quite well	Extremely well
(a)	Between successive early shifts	1	2	3	4	5
(b)	Between successive late shifts	1	2	3	4	5
(c)	Between successive night shifts	1	2	3	4	5
(d)	Between successive days off	1	2	3	4	5

3.6 How **rested** do you normally feel after sleep ? *(Circle one number for each)*

		Definitely not rested	Not very rested	Moderately rested	Quite rested	Extremely rested
(a)	Between successive early shifts	1	2	3	4	5
(b)	Between successive late shifts	1	2	3	4	5
(c)	Between successive night shifts	1	2	3	4	5
(d)	Between successive days off	1	2	3	4	5

3.7 Do you **wake up earlier** than you intended ? *(Circle one number for each)*

		Almost never	Rarely	Sometimes	Frequently	Almost always
(a)	Between successive early shifts	1	2	3	4	5
(b)	Between successive late shifts	1	2	3	4	5
(c)	Between successive night shifts	1	2	3	4	5
(d)	Between successive days off	1	2	3	4	5

3.8 Do you have **difficulty in falling** asleep ? *(Circle one number for each)*

		Almost never	Rarely	Sometimes	Frequently	Almost always
(a)	Between successive early shifts	1	2	3	4	5
(b)	Between successive late shifts	1	2	3	4	5
(c)	Between successive night shifts	1	2	3	4	5
(d)	Between successive days off	1	2	3	4	5

3.9 Do you take **sleeping pills** ? *(Circle one number for each)*

		Almost never	Rarely	Sometimes	Frequently	Almost always
(a)	Between successive early shifts	1	2	3	4	5
(b)	Between successive late shifts	1	2	3	4	5
(c)	Between successive night shifts	1	2	3	4	5
(d)	Between successive days off	1	2	3	4	5

3.10 Do you use **alcohol** to help you to sleep ? *(Circle one number for each)*

		Almost never	Rarely	Sometimes	Frequently	Almost always
(a)	Between successive early shifts	1	2	3	4	5
(b)	Between successive late shifts	1	2	3	4	5
(c)	Between successive night shifts	1	2	3	4	5
(d)	Between successive days off	1	2	3	4	5

3.11 Do you ever **feel tired** on: *(Circle one number for each)*

		Almost never	Rarely	Sometimes	Frequently	Almost always
(a)	Early shifts	1	2	3	4	5
(b)	Late shifts	1	2	3	4	5
(c)	Night shifts	1	2	3	4	5
(d)	Days off	1	2	3	4	5

Alertness

3.12 Please rate how alert or sleepy you normally feel at 2-hourly intervals before, during and after an average Early, Late or Night shift by circling the appropriate numbers. ***Please only make ratings for those times when you are normally awake.***

EARLY SHIFT

	Very alert		Alert		Neither alert nor asleep		Sleepy (but not fighting sleep)		Very sleepy (fighting sleep)
04:00	1	2	3	4	5	6	7	8	9
06:00	1	2	3	4	5	6	7	8	9
08:00	1	2	3	4	5	6	7	8	9
10:00	1	2	3	4	5	6	7	8	9
12:00	1	2	3	4	5	6	7	8	9
14:00	1	2	3	4	5	6	7	8	9
16:00	1	2	3	4	5	6	7	8	9
18:00	1	2	3	4	5	6	7	8	9
20:00	1	2	3	4	5	6	7	8	9
22:00	1	2	3	4	5	6	7	8	9
24:00	1	2	3	4	5	6	7	8	9
02:00	1	2	3	4	5	6	7	8	9

LATE SHIFT

	Very alert		Alert		Neither alert nor asleep		Sleepy (but not fighting sleep)		Very sleepy (fighting sleep)
06:00	1	2	3	4	5	6	7	8	9
08:00	1	2	3	4	5	6	7	8	9
10:00	1	2	3	4	5	6	7	8	9
12:00	1	2	3	4	5	6	7	8	9
14:00	1	2	3	4	5	6	7	8	9
16:00	1	2	3	4	5	6	7	8	9
18:00	1	2	3	4	5	6	7	8	9
20:00	1	2	3	4	5	6	7	8	9
22:00	1	2	3	4	5	6	7	8	9
24:00	1	2	3	4	5	6	7	8	9
02:00	1	2	3	4	5	6	7	8	9
04:00	1	2	3	4	5	6	7	8	9

NIGHT SHIFT

	Very alert		Alert		Neither alert nor asleep		Sleepy (but not fighting sleep)		Very sleepy (fighting sleep)
12:00	1	2	3	4	5	6	7	8	9
14:00	1	2	3	4	5	6	7	8	9
16:00	1	2	3	4	5	6	7	8	9
18:00	1	2	3	4	5	6	7	8	9
20:00	1	2	3	4	5	6	7	8	9
22:00	1	2	3	4	5	6	7	8	9
24:00	1	2	3	4	5	6	7	8	9
02:00	1	2	3	4	5	6	7	8	9
04:00	1	2	3	4	5	6	7	8	9
06:00	1	2	3	4	5	6	7	8	9
08:00	1	2	3	4	5	6	7	8	9
10:00	1	2	3	4	5	6	7	8	9

Fatigue

3.13 In the past month how much have you been bothered by :

	Not at all	A little	Somewhat	Quite a lot	Very much
spells of confusion ?	1	2	3	4	5
thoughts getting mixed up ?	1	2	3	4	5
poor concentration ?	1	2	3	4	5
can't easily make decisions ?	1	2	3	4	5
poor memory for recent events ?	1	2	3	4	5
can't take things in when speaking to people ?	1	2	3	4	5
thoughts are slow ?	1	2	3	4	5
muzzy head ?	1	2	3	4	5
can't find the right words ?	1	2	3	4	5

3.14 The following items relate to how tired or energetic you generally feel, irrespective of whether you have had enough sleep or have been working very hard. Some people appear to suffer from permanent tiredness, even on rest days and holidays, while others seem to have limitless energy. Please indicate the degree to which the following statements apply to your normal feelings. *(Circle one number for each).*

	Not at all	A little	Somewhat	Quite a lot	Very much
I generally feel I have plenty of energy	1	2	3	4	5
I feel tired most of the time	1	2	3	4	5
I usually feel lively	1	2	3	4	5

4. Your Health and Well-Being

Please indicate how frequently you experience the following, by circling the appropriate number:

How often :		Almost never	Quite seldom	Quite often	Almost always
(a)	is your appetite disturbed ?	1	2	3	4
(b)	do you have to watch what you eat to avoid stomach upsets ?	1	2	3	4
(c)	do you feel nauseous ?	1	2	3	4
(d)	do you suffer from heartburn or stomach ache ?	1	2	3	4
(e)	do you complain of stomach upsets ?	1	2	3	4
(f)	do you suffer from bloated stomach or flatulence ?	1	2	3	4
(g)	do you suffer from pain in your abdomen ?	1	2	3	4
(h)	do you suffer from constipation or diarrhoea ?	1	2	3	4
(i)	do you suffer from heart palpitations ?	1	2	3	4
(j)	do you suffer from aches and pains in your chest ?	1	2	3	4
(k)	do you suffer from dizziness ?	1	2	3	4
(l)	do you suffer from sudden rushes of blood to your head ?	1	2	3	4
(m)	do you suffer from shortness of breath when climbing the stairs normally ?	1	2	3	4
(n)	have you been told that you have high blood pressure ?	1	2	3	4
(o)	have you ever been aware of your heart beating irregularly ?	1	2	3	4
(p)	do you suffer from swollen feet ?	1	2	3	4
(q)	do you feel "tight" in your chest ?	1	2	3	4
(r)	do you suffer from minor infections such as colds and flu ?	1	2	3	4
(s)	do you suffer pain in your :				
	shoulder/neck	1	2	3	4
	back/lower back	1	2	3	4
	arm/wrist	1	2	3	4
	leg/knee	1	2	3	4

4.2 Have you been **diagnosed by your doctor** as suffering from any of the following ?

		Before starting shiftwork	Since staring shiftwork	Never
(a)	Chronic back pain	☐	☐	☐
(b)	Gastritis, duodenitis	☐	☐	☐
(c)	Gastric or duodenal ulcer	☐	☐	☐
(d)	Gallstones	☐	☐	☐
(e)	Colitis	☐	☐	☐
(f)	Sinusitis, tonsillitis	☐	☐	☐
(g)	Bronchial asthma	☐	☐	☐
(h)	Angina	☐	☐	☐
(i)	Severe heart attack (myocardial infarction)	☐	☐	☐
(j)	High blood pressure	☐	☐	☐
(k)	Cardiac arrhythmia's	☐	☐	☐
(l)	Hypercholesterolaemia (high blood cholesterol)	☐	☐	☐
(m)	Diabetes	☐	☐	☐
(n)	Cystitis	☐	☐	☐
(o)	Kidney stones	☐	☐	☐
(p)	Eczema	☐	☐	☐
(q)	Chronic anxiety	☐	☐	☐
(r)	Depression	☐	☐	☐
(s)	Arthritis	☐	☐	☐
(t)	Haemorrhoids	☐	☐	☐
(u)	Varicose veins	☐	☐	☐
(v)	Anaemia	☐	☐	☐
(w)	Headaches	☐	☐	☐
(x)	Others: ____________ *(please specify)*	☐ ☐	☐ ☐	☐ ☐

		Before starting shiftwork	Since starting shiftwork	Work day	Rest day
4.3	On average, how many cigarettes have you smoked per week and on a work day and rest day ?	☐	☐	☐	☐
4.4	On average, how many units of alcohol have you drunk per week and on a work day and a rest day ? (e.g. 1 unit = 1/2 pint lager/bitter or 1 glass of wine or 1 measure of spirit)	☐	☐	☐	☐
4.5	On average, how many cups of caffeinated coffee/tea/ cola have you drunk each day ?	☐	☐	☐	☐

4.6 The following questions deal with how you have felt in general over the past few weeks. Please circle the most appropriate answer for each question. Remember to **concentrate on present and recent complaints**, not those that you have felt in the distant past.

Have you recently :

(a) been able to concentrate on what you are doing ?	Better than usual	Same as usual	Less than usual	Much less than usual
(b) lost much sleep over worry ?	Not at all	No more than usual	Rather more than usual	Much more than usual
(c) felt that you are playing a useful part in things ?	More so than usual	Same as usual	Less than usual	Much less than usual
(d) felt capable of making decisions about things ?	More so than usual	Same as usual	Less than usual	Much less than usual
(e) felt constantly under strain ?	Not at all	No more than usual	Rather more than usual	Much more than usual
(f) felt you could not overcome your difficulties ?	Not at all	No more than usual	Rather more than usual	Much more than usual
(g) been able to enjoy your normal day to day activities ?	More so than usual	Same as usual	Less than usual	Much less than usual
(h) been able to face up to your problems ?	More so than usual	Same as usual	Less than usual	Much less than usual
(i) been feeling unhappy and depressed ?	Not at all	No more than usual	Rather more than usual	Much more than usual
(j) been losing confidence in yourself ?	Not at all	No more than usual	Rather more than usual	Much more than usual
(k) been thinking of yourself as a worthless person ?	Not at all	No more than usual	Rather more than usual	Much more than usual
(l) been feeling reasonably happy all things considered ?	Not at all	No more than usual	Rather more than usual	Much more than usual

4.7 Below are listed some descriptions of symptoms of anxiety. Please indicate the degree to which you generally or typically experience the symptom when you are feeling anxious.

	Not at all		Somewhat		Very much so
(a) I perspire	1	2	3	4	5
(b) My heart beats faster	1	2	3	4	5
(c) I worry too much over something that doesn't really matter	1	2	3	4	5
(d) I feel jittery in my body	1	2	3	4	5
(e) I imagine terrifying scenes	1	2	3	4	5
(f) I get diarrhoea	1	2	3	4	5
(g) I can't keep anxiety provoking pictures out of my mind	1	2	3	4	5
(h) I feel tense in my stomach	1	2	3	4	5
(i) Some unimportant thought runs through my mind and bothers me	1	2	3	4	5
(j) I nervously pace	1	2	3	4	5
(k) I feel like I am losing out on things because I can't make my mind up soon enough	1	2	3	4	5
(l) I feel physically immobilised	1	2	3	4	5
(m) I can't keep anxiety provoking thoughts out of my mind	1	2	3	4	5
(n) I find it difficult to concentrate because of uncontrollable thoughts	1	2	3	4	5

5. Your Social & Domestic Situation

5.1 Are you satisfied with the amount of time your shift system leaves you for :

		Not at all		Somewhat		Very much
(a)	individual hobbies and/or sport activities	1	2	3	4	5
(b)	group/team hobbies or sport activities	1	2	3	4	5
(c)	your partner	1	2	3	4	5
(d)	your close family	1	2	3	4	5
(e)	friends and relations	1	2	3	4	5
(f)	cultural events (cinema, theatre, concert), evenings out	1	2	3	4	5
(g)	joining social organisations	1	2	3	4	5
(h)	adult education classes	1	2	3	4	5
(i)	your children	1	2	3	4	5
(j)	going to bank or post office	1	2	3	4	5
(k)	going to dentist/doctor/chemist	1	2	3	4	5
(l)	having a tradesman do some work on your house	1	2	3	4	5
(m)	shopping (daily goods)	1	2	3	4	5
(n)	shopping (clothes, furniture etc.)	1	2	3	4	5
(o)	weekend outings	1	2	3	4	5
(p)	family outings	1	2	3	4	5
(q)	yourself	1	2	3	4	5
(r)	domestic tasks	1	2	3	4	5
(s)	religious activities	1	2	3	4	5

5.2 Can you now please circle the letter of those items in question 4.1 above that are of very little concern to you or that do not apply.

5.3 In general how much does your shift system interfere with the :

	Not at all		Somewhat		Very much
sort of things you would like to do in your leisure time (e.g. sport activities, hobbies etc.) ?	1	2	3	4	5
domestic things you have to do in your time off work (e.g. domestic tasks, looking after children etc.) ?	1	2	3	4	5
non-domestic things you have to do in your time off work (e.g. going to the doctor, library, bank, hairdresser, etc.) ?	1	2	3	4	5

This exercise is designed to assess how shiftworkers value different times of the day in terms of the things they like to do or have to do outside of work. Using this information, a shiftwork system can be designed in such a way as to avoid making individuals work in the hours they value most.

For example:	If you do little during the daytime but enjoy going out with friends for the evening you may rate the evening hours as being very valuable to you. Alternatively if you are busy with childcare and household chores during the day and do nothing in the evening you may rate the daytime hours as being more valuable to you than the evening hours.

Using the scale below please place what you feel to be the appropriate number in each of the boxes in the table.

Extremely valuable	Very valuable	Valuable	Fairly valuable	Neither valuable or useless	Fairly useless	Useless	Very useless	Extremely useless
1	2	3	4	5	6	7	8	9

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
12am - 3am							
3am - 6am							
6am - 9am							
9am - 12pm							
12pm - 3pm							
3pm - 6pm							
6pm - 9pm							
9pm - 12am							

6.1 How often do you eat the following meals on each of the shifts you work and on days off ? (*Circle the appropriate number for each).*

		Never	Rarely	Sometimes	Almost always	Always
EARLY	Breakfast	1	2	3	4	5
	Lunch	1	2	3	4	5
	Dinner	1	2	3	4	5
LATE	Breakfast	1	2	3	4	5
	Lunch	1	2	3	4	5
	Dinner	1	2	3	4	5
NIGHT	Breakfast	1	2	3	4	5
	Lunch	1	2	3	4	5
	Dinner	1	2	3	4	5
DAY OFF	Breakfast	1	2	3	4	5
	Lunch	1	2	3	4	5
	Dinner	1	2	3	4	5

6.2 How often do you **snack** on each of the shifts you work and on days off ? *(Circle the appropriate number for each).*

	Never	Rarely	Sometimes	Almost always	Always
EARLY	1	2	3	4	5
LATE	1	2	3	4	5
NIGHT	1	2	3	4	5
DAYS OFF	1	2	3	4	5

6.3 How regular is your eating pattern in terms of the **timing of your meals** on each of the shifts you work and on days off ? *(Circle the appropriate number for each).*

	Very regular	Fairly regular	In between	Fairly irregular	Very irregular
EARLY	1	2	3	4	5
LATE	1	2	3	4	5
NIGHT	1	2	3	4	5
DAYS OFF	1	2	3	4	5

6.4 How many **times a week do you eat a cooked main meal** when working the following shifts ?

EARLY ☐ times a week

LATE ☐ times a week

NIGHT ☐ times a week

Using the symbols below, please indicate the source of each meal you eat on each of the shifts you work.

C	**Canteen**
H	**Home**
B	**Prepared and brought in from home**
O	**Other** *(please specify)*

	Breakfast	Lunch	Dinner
EARLY	☐	☐	☐
LATE	☐	☐	☐
NIGHT	☐	☐	☐

Do you feel that you **eat a balanced and nutritious diet** during the different shifts that you work and on days off ? *(Circle the appropriate answer).*

	Never	**Rarely**	**Sometimes**	**Often**	**Always**
EARLY	1	2	3	4	5
LATE	1	2	3	4	5
NIGHT	1	2	3	4	5
DAY OFF	1	2	3	4	5

Has your weight changed since beginning shiftwork ? *(Circle the appropriate answer).*

Put on alot	**Put on some**	**Stayed the same**	**Lost some**	**Lost alot**
1	2	3	4	5

Do you have any other comments or observations relating to your eating behaviour and diet that have not been covered in this section ? If so, please try to describe them here.

____

____

____

____

____

____

____

7. Coping with Shiftwork

7.1 In general, to what extent does working shifts cause you problems with :

	Never		Somewhat		Always
(a) work performance	1	2	3	4	5
(b) sleep	1	2	3	4	5
(c) social life	1	2	3	4	5
(d) domestic life	1	2	3	4	5
(e) health and well-being	1	2	3	4	5
(f) eating behaviour and diet	1	2	3	4	5

7.2 Shiftwork affects many people in a variety of ways. Consequently shiftworkers tend to cope with the effects of shiftwork in differ ways and to different degrees. Below is a list of 8 different strategies people can use to cope with the problems they experience.

In relation to those areas mentioned above in Question 7.1, please indicate the extent to which you use (or have used) each of the coping strategies listed.

> It might help to actually think of an event concerning one of the possible problem areas. For example:
>
> **PROBLEM:** Difficulty with sleep during the day because of noise and light.
> **COPING:** Think of the extent you work on solving the problem in this situation, e.g. darken the room. If you never use this strategy circle 1. If you find that it helps and you use it alot, circle 5.

To what extent do you use the following strategies when you have <u>**any problems**</u> caused by working shifts ?	Not used	Used a little	Used somewhat	Used quite a bit	Used a great deal
(a) I work on solving the problems in the situation	1	2	3	4	5
(b) I re-organise the way I look at the situation, so things don't look so bad	1	2	3	4	5
(c) I let my emotions out	1	2	3	4	5
(d) I talk to someone about how I am feeling	1	2	3	4	5
(e) I avoid thinking or doing anything about the situation	1	2	3	4	5
(f) I wish the situation would go away or somehow be over with	1	2	3	4	5
(g) I criticise myself for what is happening	1	2	3	4	5
(h) I spend more time alone	1	2	3	4	5
(i) Other: ______ *(please specify)*	1	2	3	4	5

	Not at all		Somewhat		Very much so
7.3 To what extent do you think there are organisational problems at your work (e.g. the way your work is organised, staffing is arranged, or management decisions are implemented) ?	1	2	3	4	5
7.4 Do you find it difficult to cope with these problems ?	1	2	3	4	5

8. The type of person you are

8.1 Please tick the response for each item that best describes you.

(a) Considering only your own "feeling best" rhythm, at what time would you get up if you were entirely free to plan your day ?

05:00 - 06:30 am	1	☐
06:30 - 07:45 am	2	☐
07:45 - 09:45 am	3	☐
09:45 - 11:00 am	4	☐
11:00 - 12:00 (noon)	5	☐

(b) Considering only your own "feeling best" rhythm, at what time would you go to bed if you were entirely free to plan your day ?

08:00 - 09:00 pm	1	☐
09:00 - 10:15 pm	2	☐
10:15 - 12:30 am	3	☐
12:30 - 01:45 am	4	☐
01:45 - 03:00 a.m	5	☐

(c) Assuming normal circumstance, how easy do you find getting up in the morning ?

Not at all easy	1	☐
Slightly easy	2	☐
Fairly easy	3	☐
Very easy	4	☐

(d) How alert do you feel during the first half hour after having awakened in the morning ?

Not at all alert	1	☐
Slightly alert	2	☐
Fairly alert	3	☐
Very alert	4	☐

(e) During the first half hour after having awakened in the morning, how tired do you feel ?

Very tired	1	☐
Fairly tired	2	☐
Fairly refreshed	3	☐
Very refreshed	4	☐

(f) You have decided to engage in some physical exercise. A friend suggests that you do this one hour twice a week and that the best time for him/her is 7:00 - 8:00 am. Bearing in mind your "feeling best" rhythm, how do you think you would perform ?

Would be in good form	1	☐
Would be in reasonable from	2	☐
Would find it difficult	3	☐
Would find it very difficult	4	☐

(g) At what time in the evening do you feel tired and, as a result, in need of sleep ?

08:00 - 09:00 pm	1	☐
09:00 - 10:15 pm	2	☐
10:15 pm - 12:30 am	3	☐
12:30 - 01:45 am	4	☐
01:45 - 03:00 am	5	☐

(h) You wish to be at your peak performance for a test which you know is going to be mentally exhausting and lasting for 2 hours. You are entirely free to plan your day, and considering only your own "feeling best" rhythm, which ONE of the 4 testing times would you choose ?

- 08:00 - 10:00 am 1 ☐
- 11:00 am - 01:00 pm 2 ☐
- 03:00 - 05:00 pm 3 ☐
- 07:00 - 09:00 pm 4 ☐

(i) One hears about "morning" and "evening" types of people. Which ONE of these types do you consider yourself to be ?

- Definitely a morning type 1 ☐
- More a morning than evening type 2 ☐
- More an evening than morning type 3 ☐
- Definitely an evening type 4 ☐

(j) When would you prefer to rise (provided you have a full day's work - 8 hours) if you were totally free to arrange your time ?

- Before 06:30 am 1 ☐
- 06:30 am - 07:30 am 2 ☐
- 07:30 am - 08:30 am 3 ☐
- 08:30 am or later 4 ☐

(k) If you always had to rise at 6:00 am, what do you think it would be like ?

- Very difficult and unpleasant 1 ☐
- Rather difficult and unpleasant 2 ☐
- A little unpleasant but no great problem 3 ☐
- Easy and not unpleasant 4 ☐

(l) How long does it usually take before you "recover your senses" in the morning after rising from a night's sleep ?

- 0-10 minutes 1 ☐
- 11-20 minutes 2 ☐
- 21-40 minutes 3 ☐
- More than 40 minutes 4 ☐

(m) Please indicate the extent to which you are a morning or evening active individual.

- Pronounced morning active (morning alert, evening tired) 1 ☐
- To some extent, morning active 2 ☐
- To some extent, evening active 3 ☐
- Pronounced evening active (morning tired, evening active) 4 ☐

The following questions are concerned with your daily habits and preferences. Please indicate what you prefer to do, or can do, and not what you may be forced to do by your present work schedule or routine.

Please work through the questions as quickly as possible. It is your immediate reactions that are important, rather than a carefully deliberated answer. There are no right or wrong answers to any of the questions. Simply indicate which of the 5 alternatives best describes you, or your preferences, by circling the appropriate number on each of the questions below.

	Almost never	Seldom	Some-times	Usually	Almost always
(a) Do you tend to need more sleep than other people ?	1	2	3	4	5
(b) If you are feeling drowsy can you easily overcome it if you have something to do ?	1	2	3	4	5
(c) Can you miss out a night's sleep without too much difficulty ?	1	2	3	4	5
(d) Do you find it difficult to "wake-up" properly if you are awoken at an unusual time ?	1	2	3	4	5
(e) If you had to do a certain job in the middle of the night do you think you could do it almost as easily as at a more normal time of day ?	1	2	3	4	5
(f) Do you find it easy to "sleep in" in the morning if you got to bed very late the previous night ?	1	2	3	4	5
(g) If you go to bed late do you need to sleep in the following morning ?	1	2	3	4	5
(h) Can you easily keep alert in boring situations ?	1	2	3	4	5
(i) Do you enjoy working at unusual times of the day or night ?	1	2	3	4	5
(j) Do you feel sleepy for a while after waking in the morning ?	1	2	3	4	5
(k) Do you get up later than normal when you are on holiday ?	1	2	3	4	5
(l) If you have a lot to do can you stay up late to finish it off without feeling too tired ?	1	2	3	4	5
(m) Does the time of day have a large effect on your mood and abilities ?	1	2	3	4	5
(n) Do you find it as easy to work late at night as earlier in the day ?	1	2	3	4	5
(o) If you have to get up early one morning do you tend to feel tired all day ?	1	2	3	4	5
(p) Would you be just as happy to do something in the middle of the night as during the day ?	1	2	3	4	5
(q) Do you rely on an alarm clock, or someone else, to wake you up in the morning ?	1	2	3	4	5
(r) Are there particular times of day when you would avoid doing certain jobs if you could ?	1	2	3	4	5

8.3 The following questions regard the way you behave, feel and act. Decide which response represents your usual way of acting or feeling and circle the appropriate number. **It is your immediate reactions that are important, rather than a carefully deliberated answer.** There are no right or wrong answers.

	Almost never	Quite seldom	Quite often	Almost always
(a) Do you like plenty of excitement and bustle around you ?	1	2	3	4
(b) Does your mood go up and down ?	1	2	3	4
(c) Are you rather lively ?	1	2	3	4
(d) Do you feel "just miserable" for no good reason ?	1	2	3	4
(e) Do you like mixing with people ?	1	2	3	4
(f) When you get annoyed do you need someone friendly to talk to ?	1	2	3	4
(g) Would you call yourself happy-go-lucky ?	1	2	3	4
(h) Are you troubled about feelings of guilt ?	1	2	3	4
(i) Can you let yourself go and enjoy yourself a lot at a party ?	1	2	3	4
(j) Would you call yourself tense or "highly strung" ?	1	2	3	4
(k) Do you like practical jokes ?	1	2	3	4
(l) Do you suffer from sleeplessness ?	1	2	3	4

8.4 The following statements address some of the areas covered throughout the questionnaire. Please read each statement carefully and rate the extent to which you agree or disagree by circling the numbers provided.

	Strongly disagree	Mildly disagree	Disagree	Agree	Mildly agree	Strongly agree
(1) My own actions determine whether or not my sleep is disrupted when I work shifts	1	2	3	4	5	6
(2) It is my own fault if my sleep suffers when I am working shifts	1	2	3	4	5	6
(3) When working shifts I determine whether or not I have a proper social life	1	2	3	4	5	6
(4) When I work shifts it is my own fault if my social life suffers	1	2	3	4	5	6
(5) When working shifts my well-being depends on my own actions	1	2	3	4	5	6
(6) If I feel ill when I am working shifts it is because I have not been taking care of myself properly	1	2	3	4	5	6
(7) It is my own behaviour which determines my job performance	1	2	3	4	5	6
(8) When on shifts I am responsible for the quality of my work performance	1	2	3	4	5	6

In this questionnaire please rate your preferences and abilities and the strength of your preferences, in comparison to those of most people. Please indicate what you would prefer to do if you had a free choice, and not what you might be forced to do by your work schedule. Please circle the alternative that best describes your preference or ability, or strength of preference, in comparison to that of most people.

In comparison to most people :

1)	when would you prefer to get up if you had a day off and nothing to do ?	Much earlier	A little earlier	About the same	A little later	Much later
2)	how easily can you tell what time it is by how awake you feel ?	Much easier	A little easier	About the same	A little harder	Much harder
3)	how strong is your preference as to what time you go to bed ?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
4)	when would you prefer to meet friends (or attend social activities) on a day off ?	Much earlier	A little earlier	About the same	A little later	Much later
5)	how strong is your preference as to what time you get up if you have a day off and nothing to do?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
6)	do you find it easy to return punctually to a job after a half hour break without looking at the time ?	Much easier	A little easier	About the same	A little harder	Much harder
7)	when would you prefer to get up ?	Much earlier	A little earlier	About the same	A little later	Much later
8)	how strong is your preference as to what time you get up if you have a full day's (8 hours) work ?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
9)	when would you prefer to eat breakfast ?	Much earlier	A little earlier	About the same	A little later	Much later
10)	how strong is your preference as to what time you start work (or your job) every day ?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
11)	in general, when do you feel at your best ?	Much earlier	A little earlier	About the same	A little later	Much later
12)	if you wake up in the middle of the night do you know how many hours sleep you have had ?	Much better	A little better	About the same	A little worse	Much worse
13)	when would you prefer to start work (or your job) every day ?	Much earlier	A little earlier	About the same	A little later	Much later
14)	when would you prefer to eat your evening meal ?	Much earlier	A little earlier	About the same	A little later	Much later
15)	how strong is your preference as to what time you sit a 3-hour examination ?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
16)	how strong is your preference as to what time you get up ?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
17)	is it easy for you to know what the time is without a watch ?	Much easier	A little easier	About the same	A little harder	Much harder
18)	in general, when do you feel most active ?	Much earlier	A little earlier	About the same	A little later	Much later
19)	how strong is your preference as to what time you meet with friends (or attend social activities) on a day off ?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
20)	how strong is your preference as to what time you do hard physical work or exercise ?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
21)	when would you prefer to have an important interview at which you needed to be at your best ?	Much earlier	A little earlier	About the same	A little later	Much later
22)	when you wake up, do you know exactly what the time is without looking at a clock ?	Much better	A little better	About the same	A little worse	Much worse

In comparison to most people :

(23) how strong is your preference as to what time you have an important interview at which you need to be at your best ?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
(24) are you often shocked to learn what time it is ?	Much less often	A little less often	About the same	A little more often	Much more oft[illegible]
(25) when would you prefer to do hard physical work or exercise ?	Much earlier	A little earlier	About the same	A little later	Much later
(26) when would you prefer to go to bed ?	Much earlier	A little earlier	About the same	A little later	Much later
(27) when would you prefer to take an important 3-hour examination ?	Much earlier	A little earlier	About the same	A little later	Much later
(28) is it easy for you to wake up at the desired time without an alarm clock ?	Much easier	A little easier	About the same	A little harder	Much harder
(29) in general, how strongly does the time of day affect your feelings of activity ?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
(30) if you wake up in the middle of the night do you know the right time without looking at a clock ?	Much better	A little better	About the same	A little worse	Much worse
(31) how strong is your preference as to what time you eat your evening meal ?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
(32) how strong is your preference as to what time you eat breakfast ?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
(33) how good are you at 'knowing' what the time is when you wake up ?	Much better	A little better	About the same	A little worse	Much worse
(34) when would you prefer to do some difficult mental work which needed full concentration ?	Much earlier	A little earlier	About the same	A little later	Much later
(35) in general, how strongly doe the time of day affect how good you feel ?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
(36) how strong is your preference as to what time you you do difficult mental work which needs full concentration ?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
(37) when you are relaxing, do you know the right time without looking at a watch ?	Much better	A little better	About the same	A little worse	Much worse
(38) when would you prefer to get up if you had a full day's work (8 hours) to do ?	Much earlier	A little earlier	About the same	A little later	Much later

BEFORE HANDING BACK YOUR QUESTIONNAIRE PLEASE TAKE A MINUTE TO:

1. Check that you have entered your Personal Number in the box provided on the front cover. Please make sure that you remember this number for future stages of the research.

2. Flick back through the questionnaire to make sure that you have not missed any questions or sections by mistake. **Do not alter any of your responses.**

REMEMBER ALL INFORMATION IS STRICTLY CONFIDENTIAL

If you have any comments or observations relating to your experiences as a shiftworker that have not been covered in the questionnaire, please describe them in the space provided. If this is not adequate feel free to use the back cover or attach a separate sheet of paper.

It is possible that completing this questionnaire may have drawn your attention to problems you experience as a result of shiftwork and/or other factors. If you feel that talking to someone might help with these problems you should contact your GP. If they are unable to help they should be able to put you in touch with somebody who can.

THANK YOU FOR YOUR CO-OPERATION IN FILLING OUT THIS QUESTIONNAIRE

Appendix 5

Psychometric properties of the scales used

Table 6.2. Psychometric properties of scales used amongst production line workers in Chapter 6

Variable	Range of factor loadings	Eigenvalue	% of total variance	Alpha coefficient
Modifiers:				
Circadian:				
Morningness/Eveningness (CMS)	-.713 - +.731	4.305	33.113	.8212
Languidity/Vigorousness (CTI)	-.665 - +.597	2.511	27.899	.2470
Flexibility/Rigidity (CTI)	-.561 - +.668	2.268	25.196	.3528
Morningness/Eveningness (TAQ)	+.459 - +.806	4.529	45.295	.8610
Strength of early/late preferences (TAQ)	+.426 - +.672	3.991	33.262	.8103
Time Awareness (TAQ)	+.490 - +.781	3.356	47.939	.8136
Personality:				
Extroversion/Introversion (EPI-12)	+.492 - +.821	2.778	46.292	.7524
Engagement	+.615 - +.760	1.875	46.883	.6217
Internality/Externality (SHLOC)	+.418 - +.733	3.058	38.227	.7606
Work-related:				
Job Demand	-.445 - +.848	2.169	54.232	.4411
Job Freedom	-.608 - +.873	2.499	62.469	.8556
Decision Latitude	+.935 - +.935	1.748	87.421	.5807
General Job Satisfaction	-.786 - +.859	2.858	57.155	.8102
Outcomes:				
Neuroticism/Stability (EPI-12)	+.214 - +.776	2.521	42.012	.6933
Disengagement	+.634 - +.832	2.212	55.293	.7266
Sleep quality	-.308 - +.875	2.612	52.236	.7314
Cognitive Fatigue	+.755 - +.871	5.942	66.018	.9337
Physical Fatigue	-.774 - +.906	2.184	72.812	.8109
Gastrointestinal symptoms (PHQ)	+.517 - +.790	3.976	49.701	.8463
Cardiovascular symptoms (PHQ)	+.259 - +.666	3.054	33.928	.7430
Musculoskeletal pain (PHQ)	+.695 - +.808	2.201	55.023	.7247
Psychological Health (GHQ-12)	+.333 - +.823	5.597	46.640	.8921
Cognitive anxiety (CSAQ)	+.713 - +.873	3.962	66.034	.8937
Somatic anxiety (CSAQ)	+.473 - +.791	3.070	43.862	.7802
Social and Domestic Interference (Section 1)	-.615 - +.800	8.898	46.830	.9099
Social and Domestic Interference (Section 2)	+.772 - +.846	1.965	65.500	.7317
Shiftwork Advantages	+.286 - +.723	5.856	34.448	.8723

Table 8.3. Psychometric properties of measures used amongst oil refinery workers in Chapter 8

Scale	Range of factor loadings	Eigenvalue	% of total variance	Alpha coefficient
Modifiers:				
Circadian:				
Languidity/Vigorousness (CTI)	+.079 - +.715	2.776	30.841	.6833
Flexibility/Rigidity (CTI)	+.206 - +.682	2.302	23.583	.5867
Morningness/Eveningness (TAQ)	+.455 - +.812	4.378	43.785	.8541
Strength of early/late preferences (TAQ)	+.122 - +.723	3.120	26.003	.7055
Time Awareness (TAQ)	+.564 - +.829	3.460	49.422	.8234
Personality:				
Extroversion/Introversion (EPI-12)	+.642 - +.724	2.737	45.610	.7576
Outcomes:				
Neuroticism/Stability (EPI-12)	+.261 - +.819	2.417	40.283	.6503
Sleep quality	-.467 - +.873	2.676	53.512	.7601
Cognitive Fatigue	+.700 - +.854	5.690	63.223	.9241
Physical Fatigue	-.772 - +.889	2.045	68.154	.7588
Psychological Health (GHQ-12)	+.248 - +.836	4.100	34.169	.8002
Cognitive anxiety (CSAQ)	+.629 - +.776	3.574	51.058	.8285
Somatic anxiety (CSAQ)	+.563 - +.765	2.951	42.151	.7530

Table 9.2. Psychometric properties of measures used amongst automobile production line workers in Chapter 9

Scale	Range of factor loadings	Eigenvalue	% of total variance	Alpha coefficient
Modifiers:				
Circadian:				
Languidity/Vigorousness (CTI)	+.132 - +.748	3.310	36.783	.7515
Flexibility/Rigidity (CTI)	+.057 - +.735	2.808	31.204	.6677
Morningness/Eveningness (TAQ)	+.559 - +.832	5.112	51.116	.8915
Strength of early/late preferences (TAQ)	+.220 - +.695	4.002	30.941	.8150
Time Awareness (TAQ)	+.514 - +.850	3.612	51.604	.8279
Personality:				
Extroversion/Introversion (EPI-12)	+.585 - +.745	2.638	43.973	.7386
Internality/Externality (SHLOC)	+.486 - +.740	3.340	41.748	.7970
Engagement	+.651 - +.812	2.153	53.824	.7135
Work related:				
General Job Satisfaction	+.630 - +.852	2.741	54.829	.7811
Outcomes:				
Neuroticism/Stability (EPI-12)	+.514 - +.811	2.810	46.839	.7576
Disengagement	+.787 - +.860	2.769	69.218	.8516
Sleep quality	-.622 - +.789	2.806	46.773	.6893
Cognitive fatigue	+.635 - +.865	5.627	62.520	.9206
Physical fatigue	-.535 - + 888	1.804	60.120	.6444
Gastrointestinal symptoms (PHQ)	+.440 - +.810	3.751	46.886	.8249
Cardiovascular symptoms (PHQ)	+.510 - +.792	3.645	45.561	.8239
Musculoskeletal pain (PHQ)	+.711 - +.782	2.228	55.692	.7333
Psychological Health (GHQ-12)	+.338 - +.786	4.234	35.285	.8286
Cognitive anxiety (CSAQ)	+.636 - +.891	4.337	61.955	.8888
Somatic anxiety (CSAQ)	+.403 - +.798	3.036	43.374	.7788

Appendix 6

Psychometric properties of the reduced 29-item TAQ

Reduced 29-item TAQ

In this questionnaire we want you to rate your preferences and abilities, and the strength of your preferences, in comparison to those of most people. Please indicate what you would prefer to do if you had a free choice, and not what you might be forced to do by your work schedule. Please tick or circle the alternative that best describes your preference or ability, or strength of preference, in comparison to that of most people.

In comparison to most people:

1. when would you prefer to get up if you had a day off and nothing to do?	Much earlier	A little earlier	About the same	A little later	Much later
2. how strong is your preference as to what time you go to bed?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
3. how strong is your preference as to what time you start work (or your job) every day?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
4. in general, when do you feel at your best?	Much earlier	A little earlier	About the same	A little later	Much later
5. when would you prefer to start work (or your job) every day?	Much earlier	A little earlier	About the same	A little later	Much later
6. how strong is your preference as to what time you sit a 3-hour examination?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
7. when would you prefer to get up?	Much earlier	A little earlier	About the same	A little later	Much later
8. how strong is your preference as to what time you get up?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
9. is it easy for you to know what the time is without a watch ?	Much easier	A little easier	About the same	A little harder	Much harder
10. in general, when do you feel most active?	Much earlier	A little earlier	About the same	A little later	Much later
11. how strong is your preference as to what time you meet with friends (or attend social activities) on a day off?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
12. if you wake up in the middle of the night do you know how many hours sleep you have had?	Much better	A little better	About the same	A little worse	Much worse
13. how strong is your preference as to what time you do some hard physical work or exercise?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
14. when would you prefer to have an important interview at which you needed to be at your best?	Much earlier	A little earlier	About the same	A little later	Much later
15. when you wake up, do you know exactly what the time is without looking at a clock?	Much better	A little better	About the same	A little worse	Much worse
16. how strong is your preference as to what time you have an important interview at which you need to be at your best?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
17. when would you prefer to do hard physical work or exercise?	Much earlier	A little earlier	About the same	A little later	Much later

In comparison to most people:

18. when would you prefer to take an important 3-hour examination?	Much earlier	A little earlier	About the same	A little later	Much later
19. is it easy for you to wake up at the desired time without an alarm clock?	Much easier	A little easier	About the same	A little harder	Much harder
20. in general, how strongly does the time of day affect your feelings of activity?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
21. if you wake up in the middle of the night do you know the right time without looking at a clock?	Much better	A little better	About the same	A little worse	Much worse
22. how strong is your preference as to what time you eat your evening meal?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
23. how strong is your preference as to what time you eat breakfast?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
24. how good are you at 'knowing' what the time is when you wake up?	Much better	A little better	About the same	A little worse	Much worse
25. when would you prefer to do some difficult mental work which needed full concentration?	Much earlier	A little earlier	About the same	A little later	Much later
26. in general, how strongly does the time of day affect how good you feel?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
27. how strong is your preference as to what time you do difficult mental work which needs full concentration?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
28. when you are relaxing, do you know the right time without looking at a watch?	Much better	A little better	About the same	A little worse	Much worse
29. when would you prefer to get up if you had a full day's work (8 hours) to do?	Much earlier	A little earlier	About the same	A little later	Much later

Table 6.5. Factor loadings and inter-item correlations of the 29-item TAQ

No.	Item	Factor loading	Item-total correlation	Alpha (excl. the item)
	Factor 1 – "Morningness/Eveningness"			**Total α .8740**
1	when would you prefer to get up if you had a day off and nothing to do?	+0.487	.4127	.8707
7	when would you prefer to get up	+0.532	.4690	.8664
11	in general, when do you feel at your best?	+0.653	.6005	.8618
13	when would you prefer to start work (or your job) every day?	+0.572	.4738	.8737
18	in general, when do you feel most active?	+0.728	.7139	.8494
21	when would you prefer to have an important interview at which you needed to be at your best?	+0.775	.7047	.8503
25	when would you prefer to do hard physical work or exercise?	+0.678	.6423	.8574
27	when would you prefer to take an important 3-hour examination?	+0.742	.6848	.8526
34	when would you prefer to do some difficult mental work which needed full concentration?	+0.780	.7214	.8488
38	when would you prefer to get up if you had a full day's work (8 hours) to do?	+0.630	.5077	.8712
	Factor 2 – "Strength of Preferences			**Total α .7915**
3	how strong is your preference as to what time you go to bed?	+0.484	.3603	.7865
10	how strong is your preference as to what time you start work (or your job) every day?	+0.507	.4349	.7765
15	how strong is your preference as to what time you sit a 3-hour examination?	+0.552	.4122	.7790
16	how strong is your preference as to what time you get up?	+0.629	.4802	.7721
19	how strong is your preference as to what time you meet with friends (or attend social activities) on a day off?	+0.496	.4282	.7772
20	how strong is your preference as to what time you do some hard physical work or exercise?	+0.482	.4233	.7777
23	how strong is your preference as to what time you have an important interview at which you need to be at your best?	+0.653	.5314	.7663
29	in general, how strongly does the time of day affect your feelings of activity?	+0.502	.4080	.7791
31	how strong is your preference as to what time you eat your evening meal?	+0.518	.4282	.7776
32	how strong is your preference as to what time you eat breakfast?	+0.425	.3662	.7829
35	in general, how strongly does the time of day affect how good you feel?	+0.567	.4392	.7764
36	how strong is your preference as to what time you do difficult mental work which needs full concentration?	+0.584	.5101	.7697
	Factor 3 – "Time Awareness"			**Total α .8221**
12	if you wake up in the middle of the night do you know how many hours sleep you have had?	+0.477	.3950	.8235
17	is it easy for you to know what the time is without a watch ?	+0.695	.5535	.8001

No.	Item	Factor loading	Item-total correlation	Alpha (excl. the item)
22	when you wake up, do you know exactly what the time is without looking at a clock?	+0.718	.6080	.7910
28	is it easy for you to wake up at the desired time without an alarm clock?	+0.618	.5319	.8096
30	if you wake up in the middle of the night do you know the right time without looking at a clock?	+0.741	.6835	.7784
33	how good are you at 'knowing' what the time is when you wake up?	+0.783	.6871	.7788
37	when you are relaxing, do you know the right time without looking at a watch?	+0.657	.5312	.8039

Appendix 7

Questionnaire used amongst maintenance engineers (Chapter 7)

[redacted] Maintenance Personnel Survey of Work Hours

Section A: Your personal details.

(Please tick the appropriate answer or write answer in the space provided.)

A1. Gender: ☐ Male ☐ Female

A2. Date of birth:....../....../.......(dd/mm/yy)

A3. Are you a certifying engineer? ☐ Yes ☐ No

A4. What is the maximum weight of aircraft that you normally work on? ☐ Up to 2730 Kg ☐ 2730-5700 Kg ☐ Over 5700 Kg

A5. Who are you employed by (name of company)

....

A6. Are you employed: ☐ Directly ☐ Subcontracted

A7. Do you work in the UK? ☐ Yes ☐ No

A8. Which airport do you work at?

....

A9. No of years in Aircraft Maintenance................

A10. No of years in present job...........................

A11. No of years on present shift system................

A12. Is your shift system currently under review? ☐ Yes ☐ No

A13. No of years in shiftwork altogether ....

A14. On average, how long does it take you to travel to or from work?.........hours..........minutes

	Definitely not		Probably not		In between		Probably yes		Definitely yes
A15. Are you the sort of person who feels at their best early in the morning, and who tends to feel tired earlier than most people in the evening?	1	2	3	4	5	6	7	8	9
A16. Are you the sort of person who finds it very easy to sleep at unusual times or in unusual places?	1	2	3	4	5	6	7	8	9

Section B: Your Work Schedule.

Please use the following codes in the tables below to show (i) what you were **scheduled to work** over the past four weeks and (ii) what you **actually worked** (i.e. including any swapping of shifts, overtime, or doubling of shifts, etc.) over the past four weeks.

M = Morning (or Early), Shift
D = Day shift
A = Afternoon (or Evening) Shift
N = Night Shift
R = Rest Day
O = Other .... *(Please specify)*

(i) Scheduled to Work

Week	Mon	Tue	Wed	Thurs	Fri	Sat	Sun
1							
2							
3							
4							

(ii) Actually Worked

Week	Mon	Tue	Wed	Thurs	Fri	Sat	Sun
1							
2							
3							
4							

Each of the following questions requires you to **give four answers**. You should use the first answer (scheduled) to indicate what you have been scheduled to work according to your shift system or roster over the past year. In your second answer (normal) you should indicate what you actually normally worked (on average) over the past year (i.e. including any overtime, doubling of shifts, etc.). In your third and fourth answers you should indicate the minimum and maximum, (or the earliest and latest for questions B16-B21), that you ever worked over the past year. For example, you may be scheduled to work a 42-hour week, normally work a 50-hour one, and the actual hours in any one week might vary from a minimum of 36 hours to a maximum of 72 hours.

Please **make sure that you fill in all four answers to each question** even if all the answers are the same. If a question doesn't apply to you because of the nature of your shift system please mark it "N/A".

	Scheduled	Normal	Minimum	Maximum
B1. How many hours do you work per week?	..........hours	..........hours	..........hours	..........hours
B2. How long are your Morning or Day shifts?	..........hours	..........hours	..........hours	..........hours
B3. How long are your Afternoon shifts?	..........hours	..........hours	..........hours	..........hours
B4. How long are your Night shifts?	..........hours	..........hours	..........hours	..........hours
B5. Within each shift, how long do you work for before having a break?	..........hours	..........hours	..........hours	..........hours
B6. When you have a break within a shift how long does it last for?	..........mins	..........mins	..........mins	..........mins
B7. How many days do you spend on the Morning or Day shift before changing to a different shift or rest days?	...........days	...........days	...........days	...........days
B8. How long do you have off when you change from the Morning or Day shift to a different shift or rest days?	..........hours	..........hours	..........hours	..........hours
B9. How many days do you spend on the Afternoon shift before changing to a different shift or rest days?	...........days	...........days	...........days	...........days
B10. How long do you have off when you change from the Afternoon shift to a different shift or rest days?	..........hours	..........hours	..........hours	..........hours
B11. How many days do you spend on the Night shift before changing to a different shift or rest days?	...........days	...........days	...........days	...........days
B12. How long do you have off when you change from the Night shift to a different shift or rest days?	..........hours	..........hours	..........hours	..........hours
B13. How many successive days (of any type of shift) do you work before a break of at least one rest day?	...........days	...........days	...........days	...........days
B14. How many successive rest days do you have between blocks of shifts?	...........days	...........days	...........days	...........days
B15. How many days annual leave do you have? (including Public Holidays)	...........days	...........days	...........days	...........days

	Scheduled	Normal	Earliest	Latest
B16. What time do your Morning or Day shifts start?	............am	............am	............am	............am
B17. What time do your Morning or Day shifts finish?	............pm	............pm	............pm	............pm
B18. What time do your Afternoon shifts start?	............pm	............pm	............pm	............pm
B19. What time do your Afternoon shifts finish?	............pm	............pm	............pm	............pm
B20. What time do your Night shifts start?	............pm	............pm	............pm	............pm
B21. What time do your Night shifts finish?	............am	............am	............am	............am

For the following questions, please circle the most appropriate alternative.

B22. To what extent do you have control over the specific shifts that you work?	None	Not very much	A fair amount	Quite a lot	Complete

	None	Not very much	A fair amount	Quite a lot	Complete
B23. To what extent do you have control over the specific start and finish times of the shifts that you work?	None	Not very much	A fair amount	Quite a lot	Complete

B24. How much notice are you normally given of your shift schedule	Up to 1 day	2-6 days	7-14 days	14-28 days	More than 28 days

Section C: Sleep, Fatigue and Performance.

The following questions relate to your sleep, fatigue and performance. If a question doesn't apply to you because of the nature of your work schedule please mark it "N/A".

How much sleep do you get between:	**"Normally"**	**Minimum**	**Maximum**
C1. Successive Morning or Day shifts?	..........hours	..........hours	..........hours
C2. Successive Afternoon shifts?	..........hours	..........hours	..........hours
C3. Successive Night shifts?	..........hours	..........hours	..........hours
C4. Successive Rest days?	..........hours	..........hours	..........hours

For the following questions, please circle the most appropriate alternative.

On average, how alert or sleepy do you feel on:	**Very alert**		**Alert**		**Neither alert nor sleepy**		**Sleepy (but not fighting sleep)**		**Very sleepy (fighting sleep)**
C5. The Morning or Day shift?	1	2	3	4	5	6	7	8	9
C6. The Afternoon shift?	1	2	3	4	5	6	7	8	9
C7. The Night shift?	1	2	3	4	5	6	7	8	9

On average, how likely do you think you are to make a minor mistake on:	**Very Unlikely**		**Fairly Unlikely**		**In Between**		**Fairly Likely**		**Very Likely**
C8. The Morning or Day shift?	1	2	3	4	5	6	7	8	9
C9. The Afternoon shift?	1	2	3	4	5	6	7	8	9
C10. The Night shift?	1	2	3	4	5	6	7	8	9

On average, how <u>confident</u> are you that you can drive home safely after:	**Very Confident**		**Fairly Confident**		**In Between**		**Fairly Un-confident**		**Very Un-confident**
C11. The Morning or Day shift?	1	2	3	4	5	6	7	8	9
C12. The Afternoon shift?	1	2	3	4	5	6	7	8	9
C13. The Night shift ?	1	2	3	4	5	6	7	8	9

Section D: General.

	Not at All		**A Little**		**Some-what**		**Quite a Lot**		**Very Much**
D1. How much does your work schedule interfere with your leisure activities, family life, and non-leisure activities (e.g. going to doctor, library, bank, hairdresser, etc.)?	1	2	3	4	5	6	7	8	9
D2. Do you do any other paid work that might exacerbate the work-hour related problems that you experience?	1	2	3	4	5	6	7	8	9

	Almost Never		Quite Seldom		In Between		Quite Often		Almost Always
D3. How often do you suffer from an upset stomach or indigestion?	1	2	3	4	5	6	7	8	9
D4. How often do you suffer from minor infectious diseases (e.g. colds or flu)?	1	2	3	4	5	6	7	8	9
D5. How often do you suffer from shortness of breath, aches and pains in your chest, or heart palpitations?	1	2	3	4	5	6	7	8	9
D6. How often do you suffer from aches and pains in your muscles and/or joints?	1	2	3	4	5	6	7	8	9

	Definitely Not		Probably Not		Maybe		Probably Yes		Definitely Yes
D7. Overall, do the advantages of your work schedule outweigh the disadvantages?	1	2	3	4	5	6	7	8	9

2nd fold and tuck in ....

Body Rhythms and Shiftwork Centre
Department of Psychology
University of Wales Swansea
FREEPOST SWC4017
SWANSEA
SA2 8ZZ

1st fold..

If you have any additional comments to make about your shift system, or about this survey, please write them here:

....

....

....

....

....

....

Appendix 8

T1 and T2 questionnaires used amongst oil refinery workers (Chapter 8)

TURN-AROUND SURVEY

The following survey is part of a research programme looking at the issues people may experience as a result of working turn-around shifts. The primary aim is to help identify and reduce the problems experienced by turn-around shiftworkers by investigating how their work hours affect their health, sleep and social/domestic life.

The study will involve you completing a questionnaire at the start of your shift cycle and again at the end of the cycle.

It is possible that completing this questionnaire may draw your attention to problems you are experiencing. If you are worried that these are serious it is advised that you contact Occupational Health or your GP.

IMPORTANT

Please note that any information you provide in the questionnaires will be treated in the strictest confidence and will not be divulged to anyone (including yourself). No individual will be identified in connection with any of the research findings. We are only concerned with the information obtained from groups of shiftworkers.

PLEASE ENTER YOUR FULL NAME IN THE BOX BELOW

NAME:	

(This will ONLY be used to enable the answers from your 1st and 2nd questionnaires to be matched up)

Joanne Hill B.Sc. (Hons)

Body Rhythms & Shiftwork Centre
Department of Psychology
University of Wales Swansea
Singleton Park
Swansea
SA2 8PP

Section A: Your Personal Details

A1. Gender: *(tick one)* ❑ Male ❑ Female

A2. Date of birth: ..../........../.......... (dd/mm/yy)

A3. Are you: *(tick one)* ❑ Married/with partner ❑ Single ❑ Separated/divorced/widowed

A4. Number of dependants ....

A5. Are you employed: *(tick one)* ❑ By [redacted] ❑ Contracted

A6. How far away do you live from the refinery? ....miles

A7. On average, how long does it take you to get to and from work? ....hours ....minutes

A8. Are you living away from home (e.g. digs)? ❑ Yes ❑ No

A9. How long have you worked altogether? (since leaving school) ....years ....months ....weeks

Section B: Your Work Schedule

B1. Have you worked any sort of shiftwork before? ❑ Yes (go to B2) ❑ No (go to B3)

B2. How long have you been working shifts? ....years ....months ....weeks

B3. Have you worked turnaround shifts before? ❑ Yes ❑ No

B4. At present which shift are you working? ❑ Days ❑ Nights

B5. How long have you worked this shift? ....days

B6. How many hours are you contracted to work each week? ....hours

B7. How many hours do you actually work each week (including overtime)? ....hours

Section C: Job Satisfaction

C1. To what extent do you have control over the specific shifts that you work?	**None**	**Not very much**	**A fair amount**	**Quite a lot**	**Complete**
C2. To what extent do you have control over the specific start and finish times of the shifts you work?	**None**	**Not very much**	**A fair amount**	**Quite a lot**	**Complete**
C3. On average, how would you rate your workload on the shift you work?	**Extremely Heavy**	**Quite Heavy**	**Average**	**Quite Light**	**Extremely Light**
C4. The pacing of the job I do is:	**Entirely outside of my control**	**Somewhat outside of my control**	**In between**	**Somewhat under my control**	**Entirely under my control**
C5. Overall, do the advantages of your shift system outweigh the disadvantages?	**Definitely not**	**Probably not**	**Maybe**	**Probably yes**	**Definitely yes**
C6. All things being equal, would you prefer daywork to shiftwork?	**Definitely not**	**Probably not**	**Maybe**	**Probably yes**	**Definitely yes**
C7. How much does your shift system interfere with your leisure activities, family life, and non-leisure activities (e.g. going to the doctor, library, bank, hairdresser, etc.)?	**Not at all** 1	2	**Somewhat** 3	4	**Very much so** 5

Section D: Sleep, Fatigue & Performance

D1. At what time do you normally fall asleep and wake up at the following points? Please use 24h time (e.g., 22:30) or clea indicate "am" or "pm". If you supplement your sleep with a nap please indicate the average length of this nap.

	FALL ASLEEP	WAKE UP	NAP LENGTH
Work Day			
Before your first work day	______:______	______:______	........hours ....mins
Between two successive work days	______:______	______:______	........hours ....mins
After your last work day	______:______	______:______	........hours ....mins
Day Off			
Between two successive days off	______:______	______:______	........hours ....mins

D2. How many hours sleep do you feel you usually need per day, irrespective of whether it is a work or a rest day? ....hours ....mins

D3. How do you feel about the amount of sleep you've got over the past month? *(circle one answer for each)*

	Nowhere near enough	Could do with a lot more	Could do with a bit more	Get the right amount	Get plenty
Between successive work days	1	2	3	4	5
Between successive days off	1	2	3	4	5

D4. How well have you slept over the past month? *(circle one answer for each)*

	Extremely badly	Quite badly	Moderately well	Quite well	Extremely well
Between successive work days	1	2	3	4	5
Between successive days off	1	2	3	4	5

D5. Over the past month, how rested have you felt after sleep? *(circle one answer for each)*

	Definitely not rested	Not very rested	Moderately rested	Quite rested	Extremely rested
Between successive work days	1	2	3	4	5
Between successive days off	1	2	3	4	5

D6. Over the past month, have you woken earlier than you intended? *(circle one answer for each)*

	Almost never	Rarely	Sometimes	Frequently	Almost always
Between successive work days	1	2	3	4	5
Between successive days off	1	2	3	4	5

D7. Over the past month, have you had difficulty falling asleep? *(circle one answer for each)*

	Almost never	Rarely	Sometimes	Frequently	Almost always
Between successive work days	1	2	3	4	5
Between successive days off	1	2	3	4	5

D8. Over the past month, have you felt tired: *(circle one answer for each)*

	Almost never	Rarely	Sometimes	Frequently	Almost always
Between successive work days	1	2	3	4	5
Between successive days off	1	2	3	4	5

D9. Please rate how alert or sleepy you have normally felt, over the past month. Make ratings at 2-hourly intervals by circling the appropriate numbers. **Please only make ratings for those times when you are normally awake.**

leaf

	Very alert		Alert		Neither alert nor sleepy		Sleepy		Very sleepy (fighting sleep)
00:00	1	2	3	4	5	6	7	8	9
02:00	1	2	3	4	5	6	7	8	9
04:00	1	2	3	4	5	6	7	8	9
06:00	1	2	3	4	5	6	7	8	9
08:00	1	2	3	4	5	6	7	8	9
10:00	1	2	3	4	5	6	7	8	9
12:00	1	2	3	4	5	6	7	8	9
14:00	1	2	3	4	5	6	7	8	9
16:00	1	2	3	4	5	6	7	8	9
18:00	1	2	3	4	5	6	7	8	9
20:00	1	2	3	4	5	6	7	8	9
22:00	1	2	3	4	5	6	7	8	9

	Very unlikely		Fairly unlikely		In between		Fairly likely		Very likely
D10. On average, over the past month, how likely do you think you have been of making a minor mistake at work?	1	2	3	4	5	6	7	8	9

	Very confident		Fairly confident		In between		Fairly unconfident		Very unconfident
D11. On average, how confident are you that you can drive home safely after work?	1	2	3	4	5	6	7	8	9

D12. In the past month how much have you experienced:

	Not at all	A little	Somewhat	Quite a lot	Very much
having plenty of energy?	1	2	3	4	5
feeling tired most of the time?	1	2	3	4	5
feeling lively?	1	2	3	4	5
spells of confusion?	1	2	3	4	5
thoughts getting mixed up?	1	2	3	4	5
poor concentration?	1	2	3	4	5
can't easily make decisions?	1	2	3	4	5
poor memory for recent events?	1	2	3	4	5
can't take things in when speaking to people?	1	2	3	4	5
thoughts are slow?	1	2	3	4	5
muzzy head?	1	2	3	4	5
can't find the right words?	1	2	3	4	5

Section E: Health & Well-Being

E1. How often have you experienced the following in the past month:

	Almost never	Quite seldom	In between	Quite often	Almost always
(a) an upset stomach or indigestion	1	2	3	4	5
(b) minor infectious disease e.g., colds, flu, etc.	1	2	3	4	5
(c) shortness of breath, chest pains or heart palpitations	1	2	3	4	5
(d) aches and pains in your muscles and joints	1	2	3	4	5

E2. In the past few weeks have you:

been able to concentrate on what you are doing	Better than usual	Same as usual	Less than usual	Much less than usual
lost much sleep over worry	Not at all	No more than usual	Rather more than usual	Much more than usual
felt that you are playing a useful part in things	More so than usual	Same as usual	Less than usual	Much less than usual
felt capable of making decisions about things	More so than usual	Same as usual	Less than usual	Much less than usual
felt constantly under strain	Not at all	No more than usual	Rather more than usual	Much more than usual
felt you could not overcome your difficulties	Not at all	No more than usual	Rather more than usual	Much more than usual
been able to enjoy your normal day to day activities	More so than usual	Same as usual	Less than usual	Much less than usual
been able to face up to your problems	More so than usual	Same as usual	Less than usual	Much less than usual
been feeling unhappy and depressed	Not at all	No more than usual	Rather more than usual	Much more than usual
been losing confidence in yourself	Not at all	No more than usual	Rather more than usual	Much more than usual
been thinking of yourself as a worthless person	Not at all	No more than usual	Rather more than usual	Much more than usual
been feeling reasonably happy, all things considered	More so than usual	Same as usual	Less than usual	Much less than usual

E3. When you feel anxious, to what degree do you experience each of the following symptoms?

	Not at all		**Somewhat**		**Very much so**
I perspire	1	2	3	4	5
My heart beats faster	1	2	3	4	5
I worry too much over something that doesn't really matter	1	2	3	4	5
I feel jittery in my body	1	2	3	4	5
I imagine terrifying scenes	1	2	3	4	5
I get diarrhoea	1	2	3	4	5
I can't keep anxiety provoking pictures out of my mind	1	2	3	4	5
I feel tense in my stomach	1	2	3	4	5
Some unimportant thought runs through my mind and bothers me	1	2	3	4	5
I nervously pace	1	2	3	4	5
I feel like I am losing out on things because I can't make up my mind soon enough	1	2	3	4	5
I feel physically immobilised	1	2	3	4	5
I can't keep anxiety provoking thoughts out of my mind	1	2	3	4	5
I find it difficult to concentrate because of uncontrollable thoughts	1	2	3	4	5

Section F: The Type of Person You Are

F1. Please try to decide which response option represents your usual way of acting or feeling.

	Almost never	Quite seldom	Quite often	Almost always
Do you like plenty of excitement and bustle around you?	1	2	3	4
Does your mood go up and down?	1	2	3	4
Are you rather lively?	1	2	3	4
Do you feel 'just miserable' for no good reason?	1	2	3	4
Do you like mixing with people?	1	2	3	4
When you get annoyed do you need someone friendly to talk to?	1	2	3	4
Would you call yourself happy-go-lucky?	1	2	3	4
Are you troubled about feelings of guilt?	1	2	3	4
Can you let yourself go and enjoy yourself a lot at a party?	1	2	3	4
Would you call yourself tense or 'highly-strung'?	1	2	3	4
Do you like practical jokes?	1	2	3	4
Do you suffer from sleeplessness?	1	2	3	4

F2. The following questions are concerned with your daily habits and preferences. Please indicate what you prefer to do, or can do, and not what you may be forced to do by your present work schedule.

		Almost never	Seldom	Some times	Usually	Almost always
(a)	Do you tend to need more sleep than other people?	1	2	3	4	5
(b)	If you are feeling drowsy can you easily overcome it if you have something to do?	1	2	3	4	5
(c)	Can you miss out a night's sleep without too much difficulty?	1	2	3	4	5
(d)	Do you find it difficult to "wake-up" properly if you are awoken at an unusual time?	1	2	3	4	5
(e)	If you had to do a certain job in the middle of the night do you think you could do it almost as easily as at a more normal time of day?	1	2	3	4	5
(f)	Do you find it easy to "sleep in" in the morning if you got to bed very late the previous night?	1	2	3	4	5
(g)	If you go to bed very late do you need to sleep in the following morning?	1	2	3	4	5
(h)	Can you easily keep alert in boring situations?	1	2	3	4	5
(i)	Do you enjoy working at unusual times of day or night?	1	2	3	4	5
(j)	Do you feel sleepy for a while after waking in the morning?	1	2	3	4	5
(k)	Do you get up later than normal when you are on holiday?	1	2	3	4	5
(l)	If you have a lot to do can you stay up late to finish it off without feeling too tired?	1	2	3	4	5
(m)	Does the time of day have a large effect on your mood and abilities?	1	2	3	4	5

		Almost never	Seldom	Some times	Usually	Almost always
(n)	Do you find it as easy to work late at night as earlier in the day?	1	2	3	4	5
(o)	If you have to get up very early one morning do you tend to feel tired all day?	1	2	3	4	5
(p)	Would you be just as happy to do something in the middle of the night as during the day?	1	2	3	4	5
(q)	Do you rely on an alarm clock, or someone else, to wake you up in the morning?	1	2	3	4	5
(r)	Are there particular times of the day when you avoid doing certain jobs if you can?	1	2	3	4	5

F3. In this questionnaire we want you to rate your preferences and abilities, and the strength of your preferences, in comparison to those of most people you know. Please indicate what you would prefer to do if you had a free choice, and not what you might be forced to do by your work schedule. Please tick or circle the alternative that best describes you.

In comparison to most people you know:

1. when would you prefer to get up if you had a day off and nothing to do?	Much earlier	A little earlier	About the same	A little later	Much later
2. how easily can you tell what time it is by how awake you feel?	Much easier	A little easier	About the same	A little harder	Much harder
3. how strong is your preference as to what time you go to bed?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
4. when would you prefer to meet with friends (or attend social activities) on a day off?	Much earlier	A little earlier	About the same	A little later	Much later
5. how strong is your preference as to what time you get up if you have a day off and nothing to do?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
6. do you find it easy to return punctually to a job after a half hour break without looking at the time?	Much easier	A little easier	About the same	A little harder	Much harder
7. when would you prefer to get up?	Much earlier	A little earlier	About the same	A little later	Much later
8. how strong is your preference as to what time you get up if you have to do a full day's (8-hours) work?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
9. when would you prefer to eat breakfast?	Much earlier	A little earlier	About the same	A little later	Much later
10. how strong is your preference as to what time you start work (or your job) every day?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
11. in general, when do you feel at your best?	Much earlier	A little earlier	About the same	A little later	Much later
12. if you wake up in the middle of the night do you know how many hours sleep you have had?	Much better	A little better	About the same	A little worse	Much worse
13. when would you prefer to start work (or your job) every day?	Much earlier	A little earlier	About the same	A little later	Much later
14. when would you prefer to eat your evening meal?	Much earlier	A little earlier	About the same	A little later	Much later
15. how strong is your preference as to what time you sit a 3-hour examination?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
16. how strong is your preference as to what time you get up?	Much stronger	A little stronger	About the same	A little weaker	Much weaker

In comparison to most people you know:

17. is it easy for you to know what the time is without a watch ?	Much easier	A little easier	About the same	A little harder	Much harder
18. in general, when do you feel most active?	Much earlier	A little earlier	About the same	A little later	Much later
19. how strong is your preference as to what time you meet with friends (or attend social activities) on a day off?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
20. how strong is your preference as to what time you do some hard physical work or exercise?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
21. when would you prefer to have an important interview at which you needed to be at your best?	Much earlier	A little earlier	About the same	A little later	Much later
22. when you wake up, do you know exactly what the time is without looking at a clock?	Much better	A little better	About the same	A little worse	Much worse
23. how strong is your preference as to what time you have an important interview at which you need to be at your best?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
24. are you often shocked to learn what the time is?	Much less often	A little less often	About the same	A little more often	Much more often
25. when would you prefer to do hard physical work or exercise?	Much earlier	A little earlier	About the same	A little later	Much later
26. when would you prefer to go to bed?	Much earlier	A little earlier	About the same	A little later	Much later
27. when would you prefer to take an important 3-hour examination?	Much earlier	A little earlier	About the same	A little later	Much later
28. is it easy for you to wake up at the desired time without an alarm clock?	Much easier	A little easier	About the same	A little harder	Much harder
29. in general, how strongly does the time of day affect your feelings of activity?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
30. if you wake up in the middle of the night do you know the right time without looking at a clock?	Much better	A little better	About the same	A little worse	Much worse
31. how strong is your preference as to what time you eat your evening meal?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
32. how strong is your preference as to what time you eat breakfast?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
33. how good are you at 'knowing' what the time is when you wake up?	Much better	A little better	About the same	A little worse	Much worse
34. when would you prefer to do some difficult mental work which needed full concentration?	Much earlier	A little earlier	About the same	A little later	Much later
35. in general, how strongly does the time of day affect how good you feel?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
36. how strong is your preference as to what time you do difficult mental work which needs full concentration?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
37. when you are relaxing, do you know the right time without looking at a watch?	Much better	A little better	About the same	A little worse	Much worse
38. when would you prefer to get up if you had a full day's work (8 hours) to do?	Much earlier	A little earlier	About the same	A little later	Much later

F4. What are the 3 main **advantages** of the turnaround shift for you?

(a) ....

(b) ....

(c) ....

What are the 3 main **disadvantages** of the turnaround shift for you?

(a) ....

(b) ....

(c) ....

Thank You for your co-operation

If you have any further comments or observations about your shift system, or about this survey, please describe them here.

PLEASE CHECK THAT YOU HAVE ENTERED YOUR NAME IN THE BOX PROVIDED ON THE FRONT PAGE.

(This will ONLY be used to enable the answers from your 1st and 2nd questionnaires to be matched up)

RETURN TO:
OCCUPATIONAL HEALTH

TURN-AROUND SURVEY

PART II

The following survey is part of a research programme looking at the issues people may experience as a result of working turn-around shifts. The primary aim is to help identify and reduce the problems experienced by turn-around shiftworkers by investigating how their work hours affect their health, sleep and social/domestic life. The present questionnaire is a follow-up to the initial survey you completed at the start of the turn-around period. **IN THIS SURVEY WE ARE CONCERNED WITH HOW YOU HAVE FELT DURING THE PRESENT TURNAROUND PERIOD**

It is possible that completing this questionnaire may draw your attention to problems you are experiencing. If you are worried that these are serious it is advised that you contact Occupational Health or your GP.

IMPORTANT

Please note that any information you provide in the questionnaires will be treated in the strictest confidence and will not be divulged to anyone (including yourself). No individual will be identified in connection with any of the research findings. We are only concerned with the information obtained from groups of shiftworkers.

PLEASE ENTER YOUR FULL NAME IN THE BOX BELOW

NAME:	

(This will ONLY be used to enable the answers from your 1st and 2nd questionnaires to be matched up)

Joanne Hill B.Sc. (Hons)

Body Rhythms & Shiftwork Centre
Department of Psychology
University of Wales Swansea
Singleton Park
Swansea
SA2 8PP

IN THIS SURVEY WE ARE CONCERNED WITH HOW YOU HAVE FELT DURING THE PRESENT TURNAROUND PERIOD

Section A: Your Work Schedule

A1. How many days have you been working on the present turnaround? ……….days

A2. On average, how many hours do you work each week? (including overtime) ……….hours

A3. During turnaround periods, would you prefer to take rest days or work straight through? ❑ Yes ❑ No

A4. How many days have you taken off since beginning the turnaround? ❑ 0 ❑ 1 ❑ 2 ❑ 3 ❑ 3+

A5. Please rate how restful you have found your days off to be:

Very restful		Fairly restful		In between		Not very restful		Definitely not restful
1	2	3	4	5	6	7	8	9

Section B: Job Satisfaction

B1. To what extent do you have control over the specific hours that you work?	None	Not very much	A fair amount	Quite a lot	Complete
B2. To what extent do you have control over the specific start and finish times of the hours you work?	None	Not very much	A fair amount	Quite a lot	Complete
B3. On average, how would you rate the workload of your present job?	Extremely Heavy	Quite Heavy	Average	Quite Light	Extremely Light
B4. The pacing of the job I do is:	Entirely outside of my control	Somewhat outside of my control	In between	Somewhat under my control	Entirely under my control
B5. Overall, do the advantages of your work hours outweigh the disadvantages?	Definitely not	Probably not	Maybe	Probably yes	Definitely yes
B6. All things being equal, would you prefer daywork to shiftwork?	Definitely not	Probably not	Maybe	Probably yes	Definitely yes

B7. How much do your work hours interfere with your leisure activities, family life, and non-leisure activities (e.g. going to the doctor, library, bank, hairdresser, etc.)?

Not at all		Somewhat		Very much so
1	2	3	4	5

Section C: Sleep, Fatigue & Performance

C1. During the turnaround period what time do you normally fall asleep and wake up at the following points? Please use 24h time (e.g., 22:30) or clearly indicate "am" or "pm". *If you supplement your sleep with a nap please indicate the average length of this nap.*

	FALL ASLEEP	WAKE UP	NAP LENGTH
Work Day			
Before your first work day	_____:_____	_____:_____	……..hours ……..mins
Between two successive work days	_____:_____	_____:_____	……..hours ……..mins
After your last work day	_____:_____	_____:_____	……..hours ……..mins
Day Off			
Between two successive days off	_____:_____	_____:_____	……..hours ……..mins

C2. How many hours sleep do you feel you usually need per day, irrespective of whether it is a work or a rest day? ....hours ....mins

C3. How do you feel about the amount of sleep you've got whilst working the turnaround? *(circle one answer for each)*

	Nowhere near enough	Could do with a lot more	Could do with a bit more	Get the right amount	Get plenty
Between successive work days	1	2	3	4	5
Between successive days off	1	2	3	4	5

C4. How well have you slept whilst working the turnaround? *(circle one answer for each)*

	Extremely badly	Quite badly	Moderately well	Quite well	Extremely well
Between successive work days	1	2	3	4	5
Between successive days off	1	2	3	4	5

C5. Whilst working the turnaround, how rested have you felt after sleep? *(circle one answer for each)*

	Definitely not rested	Not very rested	Moderately rested	Quite rested	Extremely rested
Between successive work days	1	2	3	4	5
Between successive days off	1	2	3	4	5

C6. Whilst working the turnaround, have you woken earlier than you intended? *(circle one answer for each)*

	Almost never	Rarely	Sometimes	Frequently	Almost always
Between successive work days	1	2	3	4	5
Between successive days off	1	2	3	4	5

C7. Whilst working the turnaround, have you had difficulty falling asleep? *(circle one answer for each)*

	Almost never	Rarely	Sometimes	Frequently	Almost always
Between successive work days	1	2	3	4	5
Between successive days off	1	2	3	4	5

C8. Whilst working the turnaround, have you felt tired: *(circle one answer for each)*

	Almost never	Rarely	Sometimes	Frequently	Almost always
Between successive work days	1	2	3	4	5
Between successive days off	1	2	3	4	5

C9. On average, how likely do you think you have been of making a minor mistake at work?

Very unlikely		Fairly unlikely		In between		Fairly likely		Very likely
1	2	3	4	5	6	7	8	9

C10. On average, how confident are you that you can drive home safely after work?

Very confident		Fairly confident		In between		Fairly unconfident		Very unconfident
1	2	3	4	5	6	7	8	9

C11. Have you had an accident at work during the present turnaround? ☐ Yes ☐ No

C12. Please rate how alert or sleepy you have normally felt during the turnaround. Make ratings at 2-hourly intervals by circling the appropriate numbers. **Please only make ratings for those times when you are normally awake.**

	Very alert		Alert		Neither alert nor sleepy		Sleepy		Very sleepy (fighting sleep)
00:00	1	2	3	4	5	6	7	8	9
02:00	1	2	3	4	5	6	7	8	9
04:00	1	2	3	4	5	6	7	8	9
06:00	1	2	3	4	5	6	7	8	9
08:00	1	2	3	4	5	6	7	8	9
10:00	1	2	3	4	5	6	7	8	9
12:00	1	2	3	4	5	6	7	8	9
14:00	1	2	3	4	5	6	7	8	9
16:00	1	2	3	4	5	6	7	8	9
18:00	1	2	3	4	5	6	7	8	9
20:00	1	2	3	4	5	6	7	8	9
22:00	1	2	3	4	5	6	7	8	9

C13. In the past month how much have you experienced:

	Not at all	A little	Somewhat	Quite a lot	Very much
having plenty of energy?	1	2	3	4	5
feeling tired most of the time?	1	2	3	4	5
feeling lively?	1	2	3	4	5
spells of confusion?	1	2	3	4	5
thoughts getting mixed up?	1	2	3	4	5
poor concentration?	1	2	3	4	5
can't easily make decisions?	1	2	3	4	5
poor memory for recent events?	1	2	3	4	5
can't take things in when speaking to people?	1	2	3	4	5
thoughts are slow?	1	2	3	4	5
muzzy head?	1	2	3	4	5
can't find the right words?	1	2	3	4	5

Section D: Health & Well-Being

D1. How often have you experienced the following in the past month:

	Almost never	Quite seldom	In between	Quite often	Almost always
(a) an upset stomach or indigestion	1	2	3	4	5
(b) minor infectious disease e.g., colds, flu, etc.	1	2	3	4	5
(c) shortness of breath, chest pains or heart palpitations	1	2	3	4	5
(d) aches and pains in your muscles and joints	1	2	3	4	5

D2. **In the past few weeks have you:**

been able to concentrate on what you are doing	Better than usual	Same as usual	Less than usual	Much less than usual
lost much sleep over worry	Not at all	No more than usual	Rather more than usual	Much more than usual
felt that you are playing a useful part in things	More so than usual	Same as usual	Less than usual	Much less than usual
felt capable of making decisions about things	More so than usual	Same as usual	Less than usual	Much less than usual
felt constantly under strain	Not at all	No more than usual	Rather more than usual	Much more than usual
felt you could not overcome your difficulties	Not at all	No more than usual	Rather more than usual	Much more than usual
been able to enjoy your normal day to day activities	More so than usual	Same as usual	Less than usual	Much less than usual
been able to face up to your problems	More so than usual	Same as usual	Less than usual	Much less than usual
been feeling unhappy and depressed	Not at all	No more than usual	Rather more than usual	Much more than usual
been losing confidence in yourself	Not at all	No more than usual	Rather more than usual	Much more than usual
been thinking of yourself as a worthless person	Not at all	No more than usual	Rather more than usual	Much more than usual
been feeling reasonably happy, all things considered	More so than usual	Same as usual	Less than usual	Much less than usual

D3. **When you feel anxious, to what degree do you experience each of the following symptoms?**

	Not at all		Somewhat		Very much so
I perspire	1	2	3	4	5
My heart beats faster	1	2	3	4	5
I worry too much over something that doesn't really matter	1	2	3	4	5
I feel jittery in my body	1	2	3	4	5
I imagine terrifying scenes	1	2	3	4	5
I get diarrhoea	1	2	3	4	5
I can't keep anxiety provoking pictures out of my mind	1	2	3	4	5
I feel tense in my stomach	1	2	3	4	5
Some unimportant thought runs through my mind and bothers me	1	2	3	4	5
I nervously pace	1	2	3	4	5
I feel like I am losing out on things because I can't make up my mind soon enough	1	2	3	4	5
I feel physically immobilised	1	2	3	4	5
I can't keep anxiety provoking thoughts out of my mind	1	2	3	4	5
I find it difficult to concentrate because of uncontrollable thoughts	1	2	3	4	5

Section E: The Type of Person You Are

E1. Please try to decide which response option represents your usual way of acting or feeling.

	Almost never	Quite seldom	Quite often	Almost always
Do you like plenty of excitement and bustle around you?	1	2	3	4
Does your mood go up and down?	1	2	3	4
Are you rather lively?	1	2	3	4
Do you feel 'just miserable' for no good reason?	1	2	3	4
Do you like mixing with people?	1	2	3	4
When you get annoyed do you need someone friendly to talk to?	1	2	3	4
Would you call yourself happy-go-lucky?	1	2	3	4
Are you troubled about feelings of guilt?	1	2	3	4
Can you let yourself go and enjoy yourself a lot at a party?	1	2	3	4
Would you call yourself tense or 'highly-strung'?	1	2	3	4
Do you like practical jokes?	1	2	3	4
Do you suffer from sleeplessness?	1	2	3	4

E2. In this questionnaire we want you to <u>rate your preferences and abilities, and the strength of your preferences</u>, in comparison to those of most people you know. Please indicate what you would <u>prefer</u> to do if you had a free choice, and not what you might be forced to do by your work schedule. Please tick or circle the alternative that best describes you.

<u>In comparison to most people you know:</u>

1. when would you prefer to get up if you had a day off and nothing to do?	Much earlier	A little earlier	About the same	A little later	Much later
2. how easily can you tell what time it is by how awake you feel?	Much easier	A little easier	About the same	A little harder	Much harder
3. how strong is your preference as to what time you go to bed?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
4. when would you prefer to meet with friends (or attend social activities) on a day off?	Much earlier	A little earlier	About the same	A little later	Much later
5. how strong is your preference as to what time you get up if you have a day off and nothing to do?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
6. do you find it easy to return punctually to a job after a half hour break without looking at the time?	Much easier	A little easier	About the same	A little harder	Much harder
7. when would you prefer to get up?	Much earlier	A little earlier	About the same	A little later	Much later
8. how strong is your preference as to what time you get up if you have to do a full day's (8-hours) work?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
9. when would you prefer to eat breakfast?	Much earlier	A little earlier	About the same	A little later	Much later
10. how strong is your preference as to what time you start work (or your job) every day?	Much stronger	A little stronger	About the same	A little weaker	Much weaker

In comparison to most people you know:

11. in general, when do you feel at your best?	Much earlier	A little earlier	About the same	A little later	Much later
12. if you wake up in the middle of the night do you know how many hours sleep you have had?	Much better	A little better	About the same	A little worse	Much worse
13. when would you prefer to start work (or your job) every day?	Much earlier	A little earlier	About the same	A little later	Much later
14. when would you prefer to eat your evening meal?	Much earlier	A little earlier	About the same	A little later	Much later
15. how strong is your preference as to what time you sit a 3-hour examination?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
16. how strong is your preference as to what time you get up?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
17. is it easy for you to know what the time is without a watch ?	Much easier	A little easier	About the same	A little harder	Much harder
18. in general, when do you feel most active?	Much earlier	A little earlier	About the same	A little later	Much later
19. how strong is your preference as to what time you meet with friends (or attend social activities) on a day off?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
20. how strong is your preference as to what time you do some hard physical work or exercise?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
21. when would you prefer to have an important interview at which you needed to be at your best?	Much earlier	A little earlier	About the same	A little later	Much later
22. when you wake up, do you know exactly what the time is without looking at a clock?	Much better	A little better	About the same	A little worse	Much worse
23. how strong is your preference as to what time you have an important interview at which you need to be at your best?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
24. are you often shocked to learn what the time is?	Much less often	A little less often	About the same	A little more often	Much more often
25. when would you prefer to do hard physical work or exercise?	Much earlier	A little earlier	About the same	A little later	Much later
26. when would you prefer to go to bed?	Much earlier	A little earlier	About the same	A little later	Much later
27. when would you prefer to take an important 3-hour examination?	Much earlier	A little earlier	About the same	A little later	Much later
28. is it easy for you to wake up at the desired time without an alarm clock?	Much easier	A little easier	About the same	A little harder	Much harder
29. in general, how strongly does the time of day affect your feelings of activity?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
30. if you wake up in the middle of the night do you know the right time without looking at a clock?	Much better	A little better	About the same	A little worse	Much worse
31. how strong is your preference as to what time you eat your evening meal?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
32. how strong is your preference as to what time you eat breakfast?	Much stronger	A little stronger	About the same	A little weaker	Much weaker

In comparison to most people you know:

33. how good are you at 'knowing' what the time is when you wake up?	Much better	A little better	About the same	A little worse	Much worse
34. when would you prefer to do some difficult mental work which needed full concentration?	Much earlier	A little earlier	About the same	A little later	Much later
35. in general, how strongly does the time of day affect how good you feel?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
36. how strong is your preference as to what time you do difficult mental work which needs full concentration?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
37. when you are relaxing, do you know the right time without looking at a watch?	Much better	A little better	About the same	A little worse	Much worse
38. when would you prefer to get up if you had a full day's work (8 hours) to do?	Much earlier	A little earlier	About the same	A little later	Much later

E2. What are the 3 main **advantages** of the turnaround work hours for you?

(a) ....

(b) ....

(c) ....

What are the 3 main **disadvantages** of the turnaround work hours for you?

(a) ....

(b) ....

(c) ....

Thank You for your co-operation

If you have any further comments or observations about your shift system, or about this survey, please describe them below.

....

....

....

....

....

....

....

....

....

....

....

....

PLEASE CHECK THAT YOU HAVE ENTERED YOUR NAME IN THE BOX PROVIDED ON THE FRONT PAGE.

(This will ONLY be used to enable the answers from your 1st and 2nd questionnaires to be matched up)

RETURN TO:
OCCUPATIONAL HEALTH

Appendix 9

T1 and T2 questionnaires used amongst automobile plant workers (Chapter 9)

[redacted]

SHIFTWORKER SURVEY

The following survey is part of a research programme looking at the problems which people may experience as a result of working shifts. There is no particular "axe to grind" within an organisation; the primary aim being to help identify and reduce the problems experienced by individual shiftworkers.

Please note that any information you provide in the questionnaire will be treated in the strictest confidence and will not be divulged to anyone (including yourself). No individual will be identified in connection with any of the research findings. We are primarily concerned with the information obtained from groups of shiftworkers.

Throughout this questionnaire the terms "Morning", "Afternoon" and "Night" shifts are used. Please ignore the fact that these terms may differ from the ones used in your organisation. For example, you may call your "Morning" shift an "Early", while your "Afternoon" shift may be referred to as a "Late", "Evening" or "Swing" shift. If you are on a 12-hour shift system please complete the "Morning or Day" and "Night" shift sections and leave the "Afternoon" sections blank.

It is possible that completing this questionnaire may draw your attention to problems you are experiencing. If you are worried that these are serious it is advised that you contact your GP.

IMPORTANT

In order for responses from the same person to be matched up you will need a personal code. To remain anonymous, you will be asked to enter your birth-day and the initials of either your mother or father (as this should be easy to remember). Thus, if you were born on the 15th of May and your mothers name is Jane Brooks, you would enter the following in the box provided on the front of all questionnaires:

15JB

YOUR PERSONAL CODE	Day of birth	Mothers/fathers initials

When you have completed this questionnaire please return it in the pre-paid envelope provided.
Thank you for your co-operation.

Any questions or comments regarding the questionnaire or the project should be addressed to:

Joanne Hill
Body Rhythms & Shiftwork Centre, Department of Psychology,
University of Wales Swansea, Singleton Park,
Swansea. SA2 8PP

Section A: Your Personal Details

A1. Age_________

A2. ❑ Female ❑ Male

A3. Are you:

❑ Married/living with partner
❑ Single
❑ Separated/divorced/widowed

A4. Number of dependants (e.g. children)? __________

A5. On average, how long does it take you to travel to and from work?

	TO WORK	FROM WORK
Morning Shift	________mins	________mins
Afternoon Shift	________mins	________mins
Night Shift	________mins	________mins

Section B: Your Work Schedule

B1. How long have you worked altogether? ________ years ________ months

B2. How long altogether have you been working shifts? ________ years ________ months

B3. Describe your **previous** shift system ? ______________________________

B4. How long did you work on this system? ________ years ________ months

B5. *Describe your* ***present*** *shift system?* ______________________________

B6. How long have you worked your present system? ________ years ________ months

B7. How many hours are you **contracted** to work each week? ________ hours ________ minutes

B8. How many hours do you **actually** work each week? (including overtime) ________ hours ________ minutes

Section C: Job Satisfaction

C1. Please rate your workload on each shift that you work:

	Extremely Light	**Quite Light**	**Average**	**Quite Heavy**	**Extremely Heavy**
Morning or Day (12h) Shift	1	2	3	4	5
Afternoon Shift	1	2	3	4	5
Night Shift	1	2	3	4	5

	Entirely outside my control	**Somewhat outside my control**	**In between**	**Somewhat under my control**	**Entirely under my control**
C2. The pacing of the job I do is:	1	2	3	4	5

	Definitely not	**Probably not**	**In between**	**Probably yes**	**Definitely yes**
C3. Do you feel that overall the advantages of your shift system outweigh the disadvantages?	1	2	3	4	5

	Definitely not	**Probably not**	**Maybe**	**Probably yes**	**Definitely yes**
C4. All things being equal, would you prefer to give up working shifts and get a day-time job without shifts?	1	2	3	4	5

C5. The following questions relate to **general job satisfaction** not your satisfaction with you shift system. Please circle the appropriate answer for each question.

	Disagree strongly	Disagree slightly	Disagree	Neutral	Agree	Agree slightly	Agree strongly
Generally speaking I am very satisfied with this job	1	2	3	4	5	6	7
I frequently think of quitting this job	1	2	3	4	5	6	7
I am generally satisfied with the kind of work I do	1	2	3	4	5	6	7
Most people on this job are very satisfied	1	2	3	4	5	6	7
People on this job often think of quitting	1	2	3	4	5	6	7

C6. To what extent do these statements represent your opinion?

	Not at all		Somewhat		Very Much
I prefer the present shift system to the shift system previously worked?	1	2	3	4	5
I prefer the present production line to the production line previously worked?	1	2	3	4	5

Section D: Your Sleep & Fatigue

D1. At what time do you normally fall asleep and wake up at the following points? Please use 24h time (e.g., 22:30) or clearly indicate "am" or "pm". If you supplement your sleep with a nap please indicate the average length of this nap.

	FALL ASLEEP	WAKE UP	NAP LENGTH
Between two successive **morning** or **day** (12h) shifts	______:______	______:______	.....hrs ......mins
Between two successive **afternoon** shifts	______:______	______:______	.....hrs ......mins
Before your first **night** shift	______:______	______:______	.....hrs ......mins
Between two successive **night** shifts	______:______	______:______	.....hrs ......mins
After your last **night** shift	______:______	______:______	.....hrs ......mins
Between two successive **days off**	______:______	______:______	.....hrs ......mins
Between an **afternoon** and a **morning** shift (quick return)	______:______	______:______	.....hrs ......mins

D2. How many hours sleep do you feel you usually need per day, irrespective of which shift you are on?

__________ hours __________ minutes

D3. How do you feel about the amount of sleep you normally get? *(Circle one number for each)*

	Nowhere near enough	Could do with a lot more	Could do with a bit more	Get the right amount	Get plenty
Between successive morning shifts	1	2	3	4	5
Between successive afternoon shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5
Between an afternoon and a morning shift (quick return)	1	2	3	4	5

D4. How well do you normally sleep?

	Extremely badly	Quite badly	Moderately well	Quite well	Extremely well
Between successive morning shifts	1	2	3	4	5
Between successive afternoon shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5
Between an afternoon and a morning shift (quick return)	1	2	3	4	5

D5. How rested do you normally feel after sleep?

	Definitely not rested	Not very rested	Moderately rested	Quite rested	Extremely rested
Between successive morning shifts	1	2	3	4	5
Between successive afternoon shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5
Between an afternoon and a morning shift (quick return)	1	2	3	4	5

D6. Do you ever wake up earlier than you intended?

	Almost never	Rarely	Sometimes	Frequently	Almost always
Between successive morning shifts	1	2	3	4	5
Between successive afternoon shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5
Between an afternoon and a morning shift (quick return)	1	2	3	4	5

D7. Do you have difficulty in falling asleep?

	Almost never	Rarely	Sometimes	Frequently	Almost always
Between successive morning shifts	1	2	3	4	5
Between successive afternoon shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5
Between an afternoon and a morning shift (quick return)	1	2	3	4	5

D8. Do you ever feel tired on:

	Almost never	Rarely	Sometimes	Frequently	Almost always
Between successive morning shifts	1	2	3	4	5
Between successive afternoon shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5
Between an afternoon and a morning shift (quick return)	1	2	3	4	5

D9. In the past month how much have you experienced:	Not at all	A little	Some-what	Quite a lot	Very much
spells of confusion?	1	2	3	4	5
thoughts getting mixed up?	1	2	3	4	5
poor concentration?	1	2	3	4	5
can't easily make decisions?	1	2	3	4	5
poor memory for recent events?	1	2	3	4	5
can't take things in when speaking to people?	1	2	3	4	5
thoughts are slow?	1	2	3	4	5
muzzy head?	1	2	3	4	5
can't find the right words?	1	2	3	4	5
having plenty of energy?	1	2	3	4	5
feeling tired most of the time?	1	2	3	4	5
feeling lively	1	2	3	4	5

D10. Please **rate how alert or sleepy you normally feel** at 2-hourly intervals before, during and after an average Mornin Day), Afternoon or Night shift by circling the appropriate numbers. **Please only make ratings for those times w you are normally awake**

MORNING or DAY SHIFT

	Very alert		Alert		Neither alert nor sleepy		Sleepy (but not fighting sleep)		Very sleepy (fighting sleep)
04:00	1	2	3	4	5	6	7	8	9
06:00	1	2	3	4	5	6	7	8	9
08:00	1	2	3	4	5	6	7	8	9
10:00	1	2	3	4	5	6	7	8	9
12:00	1	2	3	4	5	6	7	8	9
14:00	1	2	3	4	5	6	7	8	9
16:00	1	2	3	4	5	6	7	8	9
18:00	1	2	3	4	5	6	7	8	9
20:00	1	2	3	4	5	6	7	8	9
22:00	1	2	3	4	5	6	7	8	9
24:00	1	2	3	4	5	6	7	8	9
02:00	1	2	3	4	5	6	7	8	9

AFTERNOON SHIFT

	Very alert		Alert		Neither alert nor sleepy		Sleepy (but not fighting sleep)		Very sleepy (fighting sleep)
06:00	1	2	3	4	5	6	7	8	9
08:00	1	2	3	4	5	6	7	8	9
10:00	1	2	3	4	5	6	7	8	9
12:00	1	2	3	4	5	6	7	8	9
14:00	1	2	3	4	5	6	7	8	9
16:00	1	2	3	4	5	6	7	8	9
18:00	1	2	3	4	5	6	7	8	9
20:00	1	2	3	4	5	6	7	8	9
22:00	1	2	3	4	5	6	7	8	9
24:00	1	2	3	4	5	6	7	8	9
02:00	1	2	3	4	5	6	7	8	9
04:00	1	2	3	4	5	6	7	8	9

NIGHT SHIFT

	Very alert		Alert		Neither alert nor sleepy		Sleepy (but not fighting sleep)		Very sleepy (fighting sleep)
12:00	1	2	3	4	5	6	7	8	9
14:00	1	2	3	4	5	6	7	8	9
16:00	1	2	3	4	5	6	7	8	9
18:00	1	2	3	4	5	6	7	8	9
20:00	1	2	3	4	5	6	7	8	9
22:00	1	2	3	4	5	6	7	8	9
24:00	1	2	3	4	5	6	7	8	9
02:00	1	2	3	4	5	6	7	8	9
04:00	1	2	3	4	5	6	7	8	9
06:00	1	2	3	4	5	6	7	8	9
08:00	1	2	3	4	5	6	7	8	9
10:00	1	2	3	4	5	6	7	8	9
12:00	1	2	3	4	5	6	7	8	9

Section E: Social & Domestic Life

	Not at all		Somewhat		Very much
E1. How much does your shift system interfere with your leisure time?	1	2	3	4	5
E2. How much does your shift system interfere with your domestic life?	1	2	3	4	5
E3. How much does your shift system interfere with your non-domestic life (e.g. going to doctor, library, bank, hairdresser, etc.)?	1	2	3	4	5

Section F: Health & Well-Being

F1. Please indicate how frequently you experience the following, by circling the appropriate number:

	Almost never	Quite seldom	Quite often	Almost always
How often is your appetite disturbed?	1	2	3	4
How often do you have to watch what you eat to avoid stomach upsets?	1	2	3	4
How often do you feel nauseous?	1	2	3	4
How often do you suffer from heartburn or stomach-ache?	1	2	3	4
How often do you complain of digestion difficulties?	1	2	3	4
How often do you suffer from bloated stomach or flatulence?	1	2	3	4
How often do you suffer from pain in your abdomen?	1	2	3	4
How often do you suffer from constipation or diarrhoea?	1	2	3	4
How often do you suffer from heart palpitations?	1	2	3	4
How often do you suffer from aches and pains in your chest?	1	2	3	4
How often do you suffer from dizziness?	1	2	3	4
How often do you suffer from sudden rushes of blood to your head?	1	2	3	4
Do you suffer from shortness of breath when climbing the stairs normally?	1	2	3	4
How often have you been told that you have high blood pressure?	1	2	3	4
Have you ever been aware of your heart beating irregularly?	1	2	3	4
How often do you feel "tight" in your chest?	1	2	3	4
How often do you suffer from minor infectious diseases, e.g. colds, flu, etc.?	1	2	3	4
How often do you suffer from pain in your:				
shoulder and/or neck	1	2	3	4
back and/or lower back	1	2	3	4
arm and/or wrist	1	2	3	4
leg and/or knee	1	2	3	4

F2. The following questions deal with **how you have felt in general over the past few weeks.** Please circle the most appropriate answer for each question. Remember to concentrate on present and recent complaints, not those that you have had in the distant past.

Have you recently:

been able to concentrate on what you are doing?	Better than usual	Same as usual	Less than usual	Much less than usual
lost much sleep over worry?	Not at all	No more than usual	Rather more than usual	Much more than usual
felt that you are playing a useful part in things?	More so than usual	Same as usual	Less than usual	Much less than usual
felt capable of making decisions about things?	More so than usual	Same as usual	Less than usual	Much less than usual
felt constantly under strain?	Not at all	No more than usual	Rather more than usual	Much more than usual
felt you could not overcome your difficulties?	Not at all	No more than usual	Rather more than usual	Much more than usual
been able to enjoy your normal day to day activities?	More so than usual	Same as usual	Less than usual	Much less than usual
been able to face up to your problems?	More so than usual	Same as usual	Less than usual	Much less than usual
been feeling unhappy and depressed?	Not at all	No more than usual	Rather more than usual	Much more than usual
been losing confidence in yourself?	Not at all	No more than usual	Rather more than usual	Much more than usual
been thinking of yourself as a worthless person?	Not at all	No more than usual	Rather more than usual	Much more than usual
been feeling reasonably happy all things considered?	More so than usual	About the same	Less so than usual	Much less than usual

F3. Below are listed some descriptions of **symptoms of anxiety.**

Please indicate the degree to which you **generally** or **typically** experience the symptom when **you are feeling anxious.**

		Not at all		**Some-what**		**Very much so**
(a)	I perspire	1	2	3	4	5
(b)	My heart beats faster	1	2	3	4	5
(c)	I worry too much over something that doesn't really matter	1	2	3	4	5
(d)	I feel jittery in my body	1	2	3	4	5
(e)	I imagine terrifying scenes	1	2	3	4	5
(f)	I get diarrhoea	1	2	3	4	5

		Not at all		Some-what		Very much so
(g)	I can't keep anxiety provoking pictures out of my mind	1	2	3	4	5
(h)	I feel tense in my stomach	1	2	3	4	5
(i)	Some unimportant thought runs through my mind and bothers me	1	2	3	4	5
(j)	I nervously pace	1	2	3	4	5
(k)	I feel like I am losing out on things because I can't make up my mind soon enough	1	2	3	4	5
(l)	I feel physically immobilised	1	2	3	4	5
(m)	I can't keep anxiety provoking thoughts out of my mind	1	2	3	4	5
(n)	I find it difficult to concentrate because of uncontrollable thoughts	1	2	3	4	5

Section G: The Type of Person You Are

G1. Please try to decide which response option represents your usual way of acting or feeling.

	Almost never	Quite seldom	Quite often	Almost always
Do you like plenty of excitement and bustle around you?	1	2	3	4
Does your mood go up and down?	1	2	3	4
Are you rather lively?	1	2	3	4
Do you feel 'just miserable' for no good reason?	1	2	3	4
Do you like mixing with people?	1	2	3	4
When you get annoyed do you need some-one friendly to talk to?	1	2	3	4
Would you call yourself happy-go-lucky?	1	2	3	4
Are you troubled about feelings of guilt?	1	2	3	4
Can you let yourself go and enjoy yourself a lot at a party?	1	2	3	4
Would you call yourself tense or 'highly strung'?	1	2	3	4
Do you like practical jokes?	1	2	3	4
Do you suffer from sleeplessness?	1	2	3	4

G2. The following statements address some of the areas covered throughout the questionnaire. Please read each statement carefully and rate the extent to which you agree or disagree by circling the numbers provided.

	Strongly disagree	Mildly disagree	Disagree	Agree	Mildly agree	Strongly agree
My own actions determine whether or not my sleep is disrupted when I work shifts	1	2	3	4	5	6
It is my own fault if my sleep suffers when I am working shifts	1	2	3	4	5	6
When working shifts I determine whether or not I have a proper social life	1	2	3	4	5	6
When I work shifts it is my own fault if my social life suffers	1	2	3	4	5	6
When working shifts my well-being depends on my own actions	1	2	3	4	5	6
If I feel ill when working shifts it is because I have not been taking care of myself	1	2	3	4	5	6
It is my own behaviour which determines my job performance	1	2	3	4	5	6
When working shifts I am responsible for the quality of my work performance	1	2	3	4	5	6

G3. When faced with a problem, some of us have preferred, or instinctive ways in which we immediately try to respond. How far do the following statements describe your ways of coping at work and outside work?

Typically, when faced with a problem, I immediately try:

		Very unlike me	Fairly unlike me	In between	Fairly like	Very like me
to solve it or overcome it	**at work**	1	2	3	4	5
	outside work	1	2	3	4	5
to accept it or let it be	**at work**	1	2	3	4	5
	outside work	1	2	3	4	5
to improve my feelings about it or reduce the upset	**at work**	1	2	3	4	5
	outside work	1	2	3	4	5
to accept my feelings about it or accept being upset	**at work**	1	2	3	4	5
	outside work	1	2	3	4	5

G4. The following questions are concerned with your daily habits and preferences. Please indicate what you prefer to do, or can do, and not what you may be forced to do by your present work schedule or routine. **Please work through the questions as quickly as possible.**

		Almost never	Seldom	Some times	Usually	Almost always
(a)	Do you tend to need more sleep than other people?	1	2	3	4	5
(b)	If you are feeling drowsy can you easily overcome it if you have something to do?	1	2	3	4	5
(c)	Can you miss out a night's sleep without too much difficulty?	1	2	3	4	5
(d)	Do you find it difficult to "wake-up" properly if you are awoken at an unusual time?	1	2	3	4	5
(e)	If you had to do a certain job in the middle of the night do you think you could do it almost as easily as at a more normal time of day?	1	2	3	4	5
(f)	Do you find it easy to "sleep in" in the morning if you got to bed very late the previous night?	1	2	3	4	5
(g)	If you go to bed very late do you need to sleep in the following morning?	1	2	3	4	5
(h)	Can you easily keep alert in boring situations?	1	2	3	4	5
(i)	Do you enjoy working at unusual times of day or night?	1	2	3	4	5
(j)	Do you feel sleepy for a while after waking in the morning?	1	2	3	4	5
(k)	Do you get up later than normal when you are on holiday?	1	2	3	4	5
(l)	If you have a lot to do can you stay up late to finish it off without feeling too tired?	1	2	3	4	5
(m)	Does the time of day have a large effect on your mood and abilities?	1	2	3	4	5
(n)	Do you find it as easy to work late at night as earlier in the day?	1	2	3	4	5
(o)	If you have to get up very early one morning do you tend to feel tired all day?	1	2	3	4	5
(p)	Would you be just as happy to do something in the middle of the night as during the day?	1	2	3	4	5
(q)	Do you rely on an alarm clock, or someone else, to wake you up in the morning?	1	2	3	4	5
(r)	Are there particular times of the day when you avoid doing certain jobs if you can?	1	2	3	4	5

G5. The following items relate to the people in your environment who provide you with help or support. **Each question has two parts.** For the first part list all people you know, excluding yourself, whom you can count on for help and support in the manner described. You may either give the person's initials, nickname or their relationship to you. For the second part, circle how satisfied you are with the overall support you have. If you have no support simply state 'no-one', but still rate your level of satisfaction. Do not list more than nine persons per question. ***All responses will be kept confidential.***

Whom can you really count on to distract you from your worries when you feel under stress?

a)	b)	c)
d)	e)	f)
g)	h)	i)

How satisfied are you with this support? **Very satisfied** 1 2 3 4 5 6 **Very dissatisfied**
(circle one number that best applies)

Whom can you really count on to help you feel more relaxed when you are under pressure or tense?

a)	b)	c)
d)	e)	f)
g)	h)	i)

How satisfied are you with this support? **Very satisfied** 1 2 3 4 5 6 **Very dissatisfied**
(circle one number that best applies)

Who accepts you totally, including both your worst and best points?

a)	b)	c)
d)	e)	f)
g)	h)	i)

How satisfied are you with this support? **Very satisfied** 1 2 3 4 5 6 **Very dissatisfied**
(circle one number that best applies)

Whom can you really count on to care about you, regardless of what is happening to you?

a)	b)	c)
d)	e)	f)
g)	h)	i)

How satisfied are you with this support? **Very satisfied** 1 2 3 4 5 6 **Very dissatisfied**
(circle one number that best applies)

Whom can you really count on to help you feel better when you are feeling generally down-in-the-dumps?

a)	b)	c)
d)	e)	f)
g)	h)	i)

How satisfied are you with this support? **Very satisfied** 1 2 3 4 5 6 **Very dissatisfied**
(circle one number that best applies)

Whom can you count on to console you when you are very upset?

a)	b)	c)
d)	e)	f)
g)	h)	i)

How satisfied are you with this support? **Very satisfied** 1 2 3 4 5 6 **Very dissatisfied**
(circle one number that best applies)

G6. In this questionnaire we want you to <u>rate your preferences and abilities, and the strength of your preferences</u>, in comparison to those of most people you know. Please indicate what you would <u>prefer</u> to do if you had a free choice and not what you might be forced to do by your work schedule. Please tick or circle the alternative that best describes your preference or ability, or strength of preference, in comparison to that of most people.

<u>In comparison to most people you know:</u>

1. when would you prefer to get up if you had a day off and nothing to do?	Much earlier	A little earlier	About the same	A little later	Much Later
2. how strong is your preference as to what time you go to bed?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
3. when would you prefer to get up?	Much earlier	A little earlier	About the same	A little later	Much Later
4. when would you prefer to eat breakfast?	Much earlier	A little earlier	About the same	A little later	Much Later
5. how strong is your preference as to what time you start work (or your job) every day?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
6. in general, when do you feel at your best?	Much earlier	A little earlier	About the same	A little later	Much Later
7. when would you prefer to start work (or your job) every day?	Much earlier	A little earlier	About the same	A little later	Much Later
8. how strong is your preference as to what time you sit a 3-hour examination?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
9. how strong is your preference as to what time you get up?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
10. is it easy for you to know what the time is without a watch ?	Much easier	A little easier	About the same	A little harder	Much harder
11. in general, when do you feel most active?	Much earlier	A little earlier	About the same	A little later	Much Later
12. how strong is your preference as to what time you meet with friends (or attend social activities) on a day off?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
13. how strong is your preference as to what time you do some hard physical work or exercise?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
14. when would you prefer to have an important interview at which you needed to be at your best?	Much earlier	A little earlier	About the same	A little later	Much Later
15. when you wake up, do you know exactly what the time is without looking at a clock?	Much better	A little better	About the same	A little worse	Much worse
16. how strong is your preference as to what time you have an important interview at which you need to be at your best?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
17. when would you prefer to do hard physical work or exercise?	Much earlier	A little earlier	About the same	A little later	Much Later
18. when would you prefer to take an important 3-hour examination?	Much earlier	A little earlier	About the same	A little later	Much Later
19. is it easy for you to wake up at the desired time without an alarm clock?	Much easier	A little easier	About the same	A little harder	Much harder

In comparison to most people you know:

20. if you wake up in the middle of the night do you know the right time without looking at a clock?	Much better	A little better	About the same	A little worse	Much worse
21. how strong is your preference as to what time you eat breakfast?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
22. how good are you at 'knowing' what the time is when you wake up?	Much better	A little better	About the same	A little worse	Much worse
23. when would you prefer to do some difficult mental work which needed full concentration?	Much earlier	A little earlier	About the same	A little later	Much Later
24. in general, how strongly does the time of day affect how good you feel?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
25. how strong is your preference as to what time you do difficult mental work which needs full concentration?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
26. when you are relaxing, do you know the right time without looking at a watch?	Much better	A little better	About the same	A little worse	Much worse
27. when would you prefer to get up if you had a full day's work (8 hours) to do?	Much earlier	A little earlier	About the same	A little later	Much later

G7. What are three main **advantages** of your present shift system for you?

(a) ______________________________

(b) ______________________________

(c) ______________________________

What are the three main **disadvantages** of your present shift system for you?

(a) ______________________________

(b) ______________________________

(c) ______________________________

G8. What are three main **advantages** of your present production line for you?

(a) ______________________________

(b) ______________________________

(c) ______________________________

What are the three main **disadvantages** of your present production line for you?

(a) ______________________________

(b) ______________________________

(c) ______________________________

If you have any comments or observations relating to your experiences as a shiftworker that have not been covered in this questionnaire we would be very grateful if you would describe them on the back cover.

GENERAL INFORMATION

Some people experience severe health, sleep or emotional problems as a result of working shifts. It is possible that completing this questionnaire may have drawn your attention to problems you experience as a result of shiftwork and/or other factors. If you feel that talking to someone might help with these problems it is strongly advised that you contact your GP. If they cannot help they should be able to put you in contact with someone who can.

Before returning the questionnaire please check that you have answered all of the questions.

Please do not alter any of your answers.

Thank You for your co-operation

[redacted]

SHIFTWORKER SURVEY

Part II

This survey is a follow-up to a similar questionnaire you have completed and returned, looking at the problems people may experience as a result of working shifts. Some of the questions contained within are very similar to those you answered the first time round, but are repeated here to see whether your opinions or perceptions of events have changed over time.

Please note that any information you provide in the questionnaire will be treated in the strictest confidence and will not be divulged to anyone (including yourself). No individual will be identified in connection with any of the research findings. We are primarily concerned with the information obtained from groups of shiftworkers.

Throughout this questionnaire the terms "Morning", "Afternoon" and "Night" shifts are used. Please ignore the fact that these terms may differ from the ones used in your organisation. For example, you may call your "Morning" shift an "Early", while your "Afternoon" shift may be referred to as a "Late", "Evening" or "Swing" shift. If you are on a 12-hour shift system please complete the "Morning or Day" and "Night" shift sections and leave the "Afternoon" sections blank.

YOUR PERSONAL CODE	Day of birth	Mothers/fathers initials

When you have completed this questionnaire please return it in the pre-paid envelope provided.
Thank you for your co-operation.

Any questions or comments regarding the questionnaire or the project should be addressed to:

Joanne Hill
Body Rhythms & Shiftwork Centre,
Department of Psychology,
University of Wales Swansea,
Singleton Park,
Swansea.
SA2 8PP

Section A: Your Personal Details

A1. What is your present shift system:

- ❑ 4on 4off
- ❑ 3 shift (5 days worked before a rest day)
- ❑ 3 shift (7 days worked before a rest day)
- ❑ Permanent days
- ❑ other *(please specify)* ____________________

A2. How long have you worked your present system? __________ years __________ months

A3. How many hours are you **contracted** to work each week? __________ hours

A4. How many hours do you **actually** work each week? (including overtime) __________ hours

Section B: Job Satisfaction

B1. Please rate your workload on each shift that you work:

	Extremely Light	Quite Light	Average	Quite Heavy	Extremely Heavy
Morning or Day (12h) Shift	1	2	3	4	5
Afternoon Shift	1	2	3	4	5
Night Shift	1	2	3	4	5

B2. Please rate your **overall** workload for your job in comparison to the average workload of other people in a similar occupation. *(Regardless of shift.)*

	Extremely Light	Quite Light	Average	Quite Heavy	Extremely Heavy
Physical Workload	1	2	3	4	5
Mental Workload	1	2	3	4	5
Time Pressure	1	2	3	4	5

B3. The pacing of the job I do is:	**Entirely outside my control**	**Somewhat outside my control**	**In between**	**Somewhat under my control**	**Entirely under my control**
B4. Do you feel that overall the advantages of your shift system outweigh the disadvantages?	**Definitely not**	**Probably not**	**In between**	**Probably yes**	**Definitely yes**
B5. All things being equal, would you prefer to give up working shifts and get a day-time job without shifts?	**Definitely not**	**Probably not**	**In between**	**Probably yes**	**Definitely yes**

B6. The following questions relate to **general job satisfaction** not your satisfaction with your shift system. Please circle the appropriate answer for each question.

	Disagree strongly	Disagree slightly	Disagree	Neutral	Agree	Agree slightly	Agree strongly
Generally speaking I am very satisfied with this job	1	2	3	4	5	6	7
I frequently think of quitting this job	1	2	3	4	5	6	7
I am generally satisfied with the kind of work I do	1	2	3	4	5	6	7
Most people on this job are very satisfied	1	2	3	4	5	6	7
People on this job often think of quitting	1	2	3	4	5	6	7

B7. To what extent do these statements represent your opinion?

	Not at all		Somewhat		Very Much
I prefer the present shift system to the shift system previously worked?	1	2	3	4	5
I prefer the present production line to the production line previously worked?	1	2	3	4	5

Section C: Your Sleep and Fatigue

C1. At what time do you normally fall asleep and wake up at the following points? Please use 24h time (e.g., 22:30) or clearly indicate "am" or "pm". If you supplement your sleep with a nap please indicate the average length of this nap.

	FALL ASLEEP	WAKE UP	NAP LENGTH
Between two successive **morning** or **day** (12h) shifts	______:______	______:______	.....hrs ......mins
Between two successive **afternoon** shifts	______:______	______:______	.....hrs ......mins
Before your first **night** shift	______:______	______:______	.....hrs ......mins
Between two successive **night** shifts	______:______	______:______	.....hrs ......mins
After your last **night** shift	______:______	______:______	.....hrs ......mins
Between two successive **days off**	______:______	______:______	.....hrs ......mins
Between an **afternoon** and a **morning** shift (quick return)	______:______	______:______	.....hrs ......mins

C2. How many hours sleep do you feel you usually need per day, irrespective of which shift you are on? __________ hours __________ minutes

C3. How do you feel about the amount of sleep you normally get? *(Circle one number for each)*

	Nowhere near enough	Could do with a lot more	Could do with a bit more	Get the right amount	Get plenty
Between successive morning shifts	1	2	3	4	5
Between successive afternoon shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5
Between an afternoon and a morning shift (quick return)	1	2	3	4	5

C4. How well do you normally sleep?	Extremely badly	Quite badly	Moderately well	Quite well	Extremely well
Between successive morning shifts	1	2	3	4	5
Between successive afternoon shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5
Between an afternoon and a morning shift (quick return)	1	2	3	4	5

C5. How rested do you normally feel after sleep?	Definitely not rested	Not very rested	Moderately rested	Quite rested	Extremely rested
Between successive morning shifts	1	2	3	4	5
Between successive afternoon shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5
Between an afternoon and a morning shift (quick return)	1	2	3	4	5

C6. Do you ever wake up earlier than you intended?	Almost never	Rarely	Sometimes	Frequently	Almost always
Between successive morning shifts	1	2	3	4	5
Between successive afternoon shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5
Between an afternoon and a morning shift (quick return)	1	2	3	4	5

C7. Do you have difficulty in falling asleep?	Almost never	Rarely	Sometimes	Frequently	Almost always
Between successive morning shifts	1	2	3	4	5
Between successive afternoon shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5
Between an afternoon and a morning shift (quick return)	1	2	3	4	5

C8. Do you ever feel tired on:	Almost never	Rarely	Sometimes	Frequently	Almost always
Between successive morning shifts	1	2	3	4	5
Between successive afternoon shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5
Between an afternoon and a morning shift (quick return)	1	2	3	4	5

C9. In the past month how much have you experienced:	Not at all	A little	Some-what	Quite a lot	Very much
spells of confusion?	1	2	3	4	5
thoughts getting mixed up?	1	2	3	4	5
poor concentration?	1	2	3	4	5
can't easily make decisions?	1	2	3	4	5
poor memory for recent events?	1	2	3	4	5
can't take things in when speaking to people?	1	2	3	4	5
thoughts are slow?	1	2	3	4	5
muzzy head?	1	2	3	4	5
can't find the right words?	1	2	3	4	5
having plenty of energy?	1	2	3	4	5
feeling tired most of the time?	1	2	3	4	5
feeling lively	1	2	3	4	5

C10. Please rate **how alert or sleepy you normally feel** at 2-hourly intervals before, during and after an average Morning (o Day), Afternoon or Night shift by circling the appropriate numbers. **Please only make ratings for those times whe you are normally awake**

MORNING or DAY SHIFT

	Very alert		Alert		Neither alert nor sleepy		Sleepy (but not fighting sleep)		Very sleepy (fighting sleep)
04:00	1	2	3	4	5	6	7	8	9
06:00	1	2	3	4	5	6	7	8	9
08:00	1	2	3	4	5	6	7	8	9
10:00	1	2	3	4	5	6	7	8	9
12:00	1	2	3	4	5	6	7	8	9
14:00	1	2	3	4	5	6	7	8	9
16:00	1	2	3	4	5	6	7	8	9
18:00	1	2	3	4	5	6	7	8	9
20:00	1	2	3	4	5	6	7	8	9
22:00	1	2	3	4	5	6	7	8	9
24:00	1	2	3	4	5	6	7	8	9
02:00	1	2	3	4	5	6	7	8	9

AFTERNOON SHIFT

	Very alert		Alert		Neither alert nor sleepy		Sleepy (but not fighting sleep)		Very sleepy (fighting sleep)
06:00	1	2	3	4	5	6	7	8	9
08:00	1	2	3	4	5	6	7	8	9
10:00	1	2	3	4	5	6	7	8	9
12:00	1	2	3	4	5	6	7	8	9
14:00	1	2	3	4	5	6	7	8	9
16:00	1	2	3	4	5	6	7	8	9
18:00	1	2	3	4	5	6	7	8	9
20:00	1	2	3	4	5	6	7	8	9
22:00	1	2	3	4	5	6	7	8	9
24:00	1	2	3	4	5	6	7	8	9
02:00	1	2	3	4	5	6	7	8	9
04:00	1	2	3	4	5	6	7	8	9

NIGHT SHIFT

	Very alert		Alert		Neither alert nor sleepy		Sleepy (but not fighting sleep)		Very sleepy (fighting sleep)
12:00	1	2	3	4	5	6	7	8	9
14:00	1	2	3	4	5	6	7	8	9
16:00	1	2	3	4	5	6	7	8	9
18:00	1	2	3	4	5	6	7	8	9
20:00	1	2	3	4	5	6	7	8	9
22:00	1	2	3	4	5	6	7	8	9
24:00	1	2	3	4	5	6	7	8	9
02:00	1	2	3	4	5	6	7	8	9
04:00	1	2	3	4	5	6	7	8	9
06:00	1	2	3	4	5	6	7	8	9
08:00	1	2	3	4	5	6	7	8	9
10:00	1	2	3	4	5	6	7	8	9
12:00	1	2	3	4	5	6	7	8	9

Section D: Social and Domestic Life

	Not at all		Somewhat		Very much
D1. How much does your shift system interfere with your leisure time?	1	2	3	4	5
D2. How much does your shift system interfere with your domestic life?	1	2	3	4	5
D3. How much does your shift system interfere with your non-domestic life (e.g. going to doctor, library, bank, hairdresser, etc.)?	1	2	3	4	5

Section E: Health and Well-Being

E1. Please indicate how frequently you experience the following, by circling the appropriate number:

	Almost never	Quite seldom	Quite often	Almost always
How often is your appetite disturbed?	1	2	3	4
How often do you have to watch what you eat to avoid stomach upsets?	1	2	3	4
How often do you feel nauseous?	1	2	3	4
How often do you suffer from heartburn or stomach-ache?	1	2	3	4
How often do you complain of digestion difficulties?	1	2	3	4
How often do you suffer from bloated stomach or flatulence?	1	2	3	4
How often do you suffer from pain in your abdomen?	1	2	3	4
How often do you suffer from constipation or diarrhoea?	1	2	3	4

	Almost never	Quite seldom	Quite often	Almost always
How often do you suffer from heart palpitations?	1	2	3	4
How often do you suffer from aches and pains in your chest?	1	2	3	4
How often do you suffer from dizziness?	1	2	3	4
How often do you suffer from sudden rushes of blood to your head?	1	2	3	4
Do you suffer from shortness of breath when climbing the stairs normally?	1	2	3	4
How often have you been told that you have high blood pressure?	1	2	3	4
Have you ever been aware of your heart beating irregularly?	1	2	3	4
How often do you feel "tight" in your chest?	1	2	3	4
How often do you suffer from minor infectious diseases, e.g. colds, flu, etc.?	1	2	3	4
How often do you suffer from pain in your:				
shoulder and/or neck	1	2	3	4
back and/or lower back	1	2	3	4
arm and/or wrist	1	2	3	4
leg and/or knee	1	2	3	4

E2. The following questions deal with **how you have felt in general over the past few weeks.** Please circle the most appropriate answer for each question. Remember to concentrate on present and recent complaints, not those that you have had in the distant past.

Have you recently:

been able to concentrate on what you are doing?	Better than usual	Same as usual	Less than usual	Much less than usual
lost much sleep over worry?	Not at all	No more than usual	Rather more than usual	Much more than usual
felt that you are playing a useful part in things?	More so than usual	Same as usual	Less than usual	Much less than usual
felt capable of making decisions about things?	More so than usual	Same as usual	Less than usual	Much less than usual
felt constantly under strain?	Not at all	No more than usual	Rather more than usual	Much more than usual
felt you could not overcome your difficulties?	Not at all	No more than usual	Rather more than usual	Much more than usual
been able to enjoy your normal day to day activities?	More so than usual	Same as usual	Less than usual	Much less than usual
been able to face up to your problems?	More so than usual	Same as usual	Less than usual	Much less than usual

been feeling unhappy and depressed?	Not at all	No more than usual	Rather more than usual	Much more than usual
been losing confidence in yourself?	Not at all	No more than usual	Rather more than usual	Much more than usual
been thinking of yourself as a worthless person?	Not at all	No more than usual	Rather more than usual	Much more than usual
been feeling reasonably happy all things considered?	More so than usual	About the same	Less so than usual	Much less than usual

E3. Below are listed some descriptions of **symptoms of anxiety.** Please indicate the degree to which you **generally** or **typically** experience the symptom when **you are feeling anxious.**

		Not at all		**Some-what**		**Very much so**
(a)	I perspire	1	2	3	4	5
(b)	My heart beats faster	1	2	3	4	5
(c)	I worry too much over something that doesn't really matter	1	2	3	4	5
(d)	I feel jittery in my body	1	2	3	4	5
(e)	I imagine terrifying scenes	1	2	3	4	5
(f)	I get diarrhoea	1	2	3	4	5
(g)	I can't keep anxiety provoking pictures out of my mind	1	2	3	4	5
(h)	I feel tense in my stomach	1	2	3	4	5
(i)	Some unimportant thought runs through my mind and bothers me	1	2	3	4	5
(j)	I nervously pace	1	2	3	4	5
(k)	I feel like I am losing out on things because I can't make up my mind soon enough	1	2	3	4	5
(l)	I feel physically immobilised	1	2	3	4	5
(m)	I can't keep anxiety provoking thoughts out of my mind	1	2	3	4	5
(n)	I find it difficult to concentrate because of uncontrollable thoughts	1	2	3	4	5

Section F: The Type of Person You Are

F1. When faced with a problem, some of us have preferred, or instinctive ways in which we immediately try to respond. How far do the following statements describe your ways of coping at work and outside work?

Typically, when faced with a problem, I immediately try:

		Very unlike me	Fairly unlike me	In between	Fairly like	Very like me
to solve it or overcome it	**at work**	1	2	3	4	5
	outside work	1	2	3	4	5
to accept it or let it be	**at work**	1	2	3	4	5
	outside work	1	2	3	4	5
to improve my feelings about it or reduce the upset	**at work**	1	2	3	4	5
	outside work	1	2	3	4	5
to accept my feelings about it or accept being upset	**at work**	1	2	3	4	5
	outside work	1	2	3	4	5

F2. In this questionnaire we want you to rate your preferences and abilities, and the strength of your preferences, in compariso[n] those of most people you know. **Please indicate what you would prefer to do if you had a free choice, and not what y[ou] might be forced to do by your work schedule.** Please tick or circle the alternative that best describes your preferenc[e] ability, or strength of preference, in comparison to that of most people.

In comparison to most people:

1. when would you prefer to get up if you had a day off and nothing to do?	Much earlier	A little earlier	About the same	A little later	Much later
2. how easily can you tell what time it is by how awake you feel?	Much easier	A little easier	About the same	A little harder	Much harder
3. how strong is your preference as to what time you go to bed?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
4. when would you prefer to meet with friends (or attend social activities) on a day off?	Much earlier	A little earlier	About the same	A little later	Much later
5. how strong is your preference as to what time you get up if you have a day off and nothing to do?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
6. do you find it easy to return punctually to a job after a half hour break without looking at the time?	Much easier	A little easier	About the same	A little harder	Much harder
7. when would you prefer to get up?	Much earlier	A little earlier	About the same	A little later	Much later
8. how strong is your preference as to what time you get up if you have to do a full day's (8-hours) work?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
9. when would you prefer to eat breakfast?	Much earlier	A little earlier	About the same	A little later	Much later

In comparison to most people:

10. how strong is your preference as to what time you start work (or your job) every day?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
11. in general, when do you feel at your best?	Much earlier	A little earlier	About the same	A little later	Much later
12. if you wake up in the middle of the night do you know how many hours sleep you have had?	Much better	A little better	About the same	A little worse	Much worse
13. when would you prefer to start work (or your job) every day?	Much earlier	A little earlier	About the same	A little later	Much later
14. when would you prefer to eat your evening meal?	Much earlier	A little earlier	About the same	A little later	Much later
15. how strong is your preference as to what time you sit a 3-hour examination?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
16. how strong is your preference as to what time you get up?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
17. is it easy for you to know what the time is without a watch ?	Much easier	A little easier	About the same	A little harder	Much harder
18. in general, when do you feel most active?	Much earlier	A little earlier	About the same	A little later	Much later
19. how strong is your preference as to what time you meet with friends (or attend social activities) on a day off?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
20. how strong is your preference as to what time you do some hard physical work or exercise?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
21. when would you prefer to have an important interview at which you needed to be at your best?	Much earlier	A little earlier	About the same	A little later	Much later
22. when you wake up, do you know exactly what the time is without looking at a clock?	Much better	A little better	About the same	A little worse	Much worse
23. how strong is your preference as to what time you have an important interview at which you need to be at your best?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
24. are you often shocked to learn what the time is?	Much less often	A little less often	About the same	A little more often	Much more often
25. when would you prefer to do hard physical work or exercise?	Much earlier	A little earlier	About the same	A little later	Much later
26. when would you prefer to go to bed?	Much earlier	A little earlier	About the same	A little later	Much later
27. when would you prefer to take an important 3-hour examination?	Much earlier	A little earlier	About the same	A little later	Much later
28. is it easy for you to wake up at the desired time without an alarm clock?	Much easier	A little easier	About the same	A little harder	Much harder
29. in general, how strongly does the time of day affect your feelings of activity?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
30. if you wake up in the middle of the night do you know the right time without looking at a clock?	Much better	A little better	About the same	A little worse	Much worse
31. how strong is your preference as to what time you eat your evening meal?	Much stronger	A little stronger	About the same	A little weaker	Much weaker

In comparison to most people:

32. how strong is your preference as to what time you eat breakfast?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
33. how good are you at 'knowing' what the time is when you wake up?	Much better	A little better	About the same	A little worse	Much worse
34. when would you prefer to do some difficult mental work which needed full concentration?	Much earlier	A little earlier	About the same	A little later	Much later
35. in general, how strongly does the time of day affect how good you feel?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
36. how strong is your preference as to what time you do difficult mental work which needs full concentration?	Much stronger	A little stronger	About the same	A little weaker	Much weaker
37. when you are relaxing, do you know the right time without looking at a watch?	Much better	A little better	About the same	A little worse	Much worse
38. when would you prefer to get up if you had a full day's work (8 hours) to do?	Much earlier	A little earlier	About the same	A little later	Much later

F3. What are three main **advantages** of your present shift system for you?

(a) ____________________

(b) ____________________

(c) ____________________

What are the three main **disadvantages** of your present shift system for you?

(a) ____________________

(b) ____________________

(c) ____________________

F4. What are three main **advantages** of your present production line/work area for you?

(a) ____________________

(b) ____________________

(c) ____________________

What are the three main **disadvantages** of your present production line/work area for you?

(a) ____________________

(b) ____________________

(c) ____________________

If you have any comments or observations relating to your experiences as a shiftworker that have not been covered in this questionnaire we would be very grateful if you would describe them on the back cover.

GENERAL INFORMATION

Some people experience severe health, sleep or emotional problems as a result of working shifts. It is possible that completing this questionnaire may have drawn your attention to problems you experience as a result of shiftwork and/or other factors. If you feel that talking to someone might help with these problems it is strongly advised that you contact your GP. If they cannot help they should be able to put you in contact with someone who can.

Before returning the questionnaire please check that you have answered all of the questions.

Please do not alter any of your answers.

Thank You for your co-operation