THE UNIVERSITY OF
SYDNEY

PLAYING RELATED MUSCULOSKELETAL DISORDERS

IN INSTRUMENTAL MUSICIANS

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BSc, Grad Dip Phty, Grad Dip Adult Ed

Thesis submitted in fulfilment of the requirements for the degree of
Master of Applied Science (Physiotherapy) by Research

School of Physiotherapy
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2005

SUPERVISOR'S CERTIFICATE

This is to certify that the thesis entitled "Playing related musculoskeletal disorders in instrumental musicians" submitted by Jacquelin Capell in fulfilment of the requirements for the degree of Master of Applied Science (Physiotherapy) by Research is in a form ready for examination.

CANDIDATE'S CERTIFICATE

I, Jacquelin Capell, hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of a university or other institute of higher learning, except where due acknowledgement is made in the text.

ACKNOWLEDGEMENTS

This thesis is dedicated in loving memory of Damien Capell and Imogen King.

I thank my supervisors Joy Higgs, Roger Adams and Elfreda Marshall for their support in this endeavour and Martin Mackey for his assistance regarding ergonomic content.

I would like to express my gratitude to my supervisor Professor Joy Higgs, whose enthusiasm, commitment, knowledge, experience and professionalism enabled me to complete this thesis.

I would particularly like to thank Dr Roger Adams for his valuable guidance and insight into motor performance and learning.

I am indebted to the musicians who kindly gave of their time and experience for these studies.

Special thanks are due to Ms Ngaire Pettit-Young, Dr Judith Stubbs and Dr Natalie Bolzan for their encouragement, valuable comments, and feedback on this thesis.

Thanks also to my family and friends for their support and tolerance during the course of this thesis.

ABSTRACT

The specialist literature on the occupation of music production identifies a high level of playing related musculoskeletal disorders (PRMDs) reported by musicians. Studies report substantial professional, emotional, and financial costs, in terms of lost opportunities, careers and time. Biomechanical and ergonomic causes are proposed by many authors. The cause of PRMDs most frequently cited is overuse, related to quantity of work, although some authors argue that the term misuse is more appropriate.

The research evidence for the strategies which musicians can employ to protect themselves against PRMDs has often been based on the experiences of clinicians dealing with injured populations. Some authors compare musicians to elite athletes, and thus some advice to musicians is also based on research and practice in the field of sports medicine.

The purpose of this research was to investigate whether it is possible to identify positive instances of prevention and management of PRMDs by successful, professional musicians and to identify musicians' views concerning useful strategies for protecting themselves against PRMDs. The literature reports that the true incidence of PRMDs is underestimated and that some injured musicians may drop out of the profession. Considering this pattern, the group of musicians who maintain long term careers while preventing or managing injury may be considered as survivors and it was anticipated that they could have valuable advice for those starting out in the profession. A self-reporting questionnaire and semistructured interviews were used to investigate the strategies which musicians report using or consider important.

The musicians surveyed and interviewed were able to identify the factors which they believe to contribute to, and those which mitigate against PRMDs. The major theme in the research findings was the belief, grounded in their professional experience and "player's wisdom", that PRMDs are preventable given certain conditions. These conditions related to good teaching, the acquisition of professional craft knowledge (i.e. "player's wisdom") and appropriate environment management. The first two of these factors promoted playing and self-management behaviours that made PRMD prevention

feasible and facilitated efficient PRMD management. The third made such valuable behaviours more achievable.

The thesis discusses implications arising from the research, particularly in relation to the training of student musicians in PRMD prevention and management. Training in these areas needs to be explicit. "Good teaching" was seen to encompass many factors, such as helping students learn to engage in appropriate playing postures and techniques, management of excessive muscle tension, appropriate individual musician-instrument set-up, learning the importance of early intervention when playing-related pain presented, and ergonomic considerations such as how to position one's self in an orchestral setting.

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CHAPTER 1

INTRODUCTION

The purpose of this research is to investigate whether the protocols and treatment regimes for the prevention or rehabilitation of playing-related musculoskeletal disorders (PRMDs), as proposed by various authors, are consistent with the behaviours and professional knowledge of professional musicians who successfully prevent or minimize PRMDs. Secondly, an attempt is made to ascertain any common attributes amongst musicians who do not experience PRMDs. The aim is not to ask questions about specific types of pain and localities, as these topics have been extensively covered in the literature.

A commitment to producing music of quality over a playing lifetime has costs. It is well documented that many musicians, at student, amateur and professional levels, experience musculoskeletal pain related to playing their instruments, as well as other disorders such as playing-related anxiety and hearing impairments (Elbaum 1986, Eller et al 1992, Fishbein et al 1988, Fjellman-Wiklund and Sundelin 1998, Fry 1984, 1986b, 1986c, Hartsell and Tata 1991, Horvath 2001, Lockwood 1989, Mandel 1990, Owen 1985, Revak, 1988, Slade et al 1999, Weiss et al 2001, Zaza 1998, Zetterberg et al 1998). These problems have been recognized for over a hundred years, with Poore's writings on the subject dating from 1887 often being cited (see Bejjani et al 1996, Bird 1989, Fry 1986c, Hutson 1997, Lockwood 1989, Norris 1996).

Despite the existence of these problems having been noted for many years, response by the medical profession, teaching institutions and employers in terms of treatment and prevention of PRMDs has been only recent. Identification of these disorders in musicians is vital, as is well-planned research, to formulate appropriate prevention and treatment strategies to reduce their impact with regard to career longevity, and financial and other human costs.

The dissemination of accurate preventive information in particular would help musicians to reduce the incidence of injury and increase the knowledge base of medical professionals working with musicians (Horvath 2001). Although there have been references in medical literature to musicians' problems since the 1880s, Lockwood (1989) has suggested that the

origin of performing-arts medicine as a discipline may have been the 1972 Danube Symposium on Neurology. According to Nagai and Eng in 1992, despite a growing interest in the medical problems of performing musicians, the discipline had "only recently begun to flourish" (p.23). Palac (1995, p.69) noted that the awareness of musical injuries in string players had risen sharply from about 1985, "with the birth of the field of music medicine". These time frames coincide with Horvath's (2001) claim to "have seen the explosion of interest in and the establishment of the field of Performing Arts Medicine from its very inception" (p.1), in the early 1980s.

The rapid increase in interest in development of musicians' clinics and relevant research has been contemporaneous with an international epidemic of work-related musculoskeletal disorders (Zaza 1998). As an occupational group musicians have particular characteristics which require specific research, including the early age at which most commence training, the ergonomics of their instruments, and the nature of their workplaces. These points are explored in further detail in Chapter Two. It has been suggested that ergonomic investigation and intervention in the performing arts is scanty (Chan et al 2000, p.340) compared to that in other fields of work such as newspaper publication and supermarkets. Although musicians are certainly not alone in experiencing occupationally-related musculoskeletal disorders, the lack of specific research into treatment and effective prevention may contribute to the persistence of high injury rates.

According to Hartsell and Tata (1991, p.13), "generally, two categories of musicians exist; the performer and the student. The members of these categories may be distinct or interrelated". Hartsell and Tata further subdivided performers into professionals and amateurs. The focus of my research developed from the challenges I experienced when treating student and professional classically-trained musicians. These clinical challenges included seeking a more complete understanding of the variety of circumstances which impinge on musicians, and which may result in the development of PRMDs, and thus the identification of possible avenues for prevention of PRMDs. Although the focus of my research is the musculoskeletal disorders affecting professional performing classical musicians, literature relevant to student musicians is included in this review because the types of injury reported are the same as those affecting experienced musicians. In a number

of studies, findings have been reported based on mixed samples, including music school, undergraduate and postgraduate students, and experienced professionals.

Fishbein et al (1988) stated that measuring the prevalence[1] of a problem often underestimates the risk or incidence of a problem. For instance, musicians with the most severe problems may no longer be able to perform, and therefore may have dropped out of the population and would not appear in "musicians with injuries" statistics. Musicians who continue to perform at a professional level could be regarded as the survivors, and it is the behaviours of this group with respect to injury management and prevention that are considered here. Specifically, the question posed is "What can be learnt from professional performing musicians that might assist future musicians to avoid PRMDs?"

Most musicians begin serious musical studies at an early age. Owens (1985) reported that, on average, musicians begin studies at about eight years of age, but that some, particularly violinists, start as early as two. Although pain and discomfort are reported in younger players, Owens commented that it was common to find a pattern of injury emerging, particularly in violinists, after about 20 years of practice and performance. In other words, by the time pain and discomfort disrupt playing, the average musician has reinforced patterns of playing involving high levels of sensorimotor skill for many years. This point may have implications for musicians seeking to change aspects of their playing, in terms of how to identify the component of playing technique (or playing-related behaviour) that is contributing to pain and dysfunction, and in terms of how to best effect, integrate and consolidate change to prevent any recurrence of pain or dysfunction.

Literature relating to the above points, as well as to types of injury, causes and possible avenues for treatment and prevention is considered in Chapter Two.

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[1] For the purposes of this thesis, the following definitions are used:
Prevalence is defined as the proportion of persons in a defined population at a given point in time possessing the criteria (for example, a medical condition) under consideration (Fletcher et al, 1996, p.58).
Point prevalence is measured at the time of the survey for each person, although not necessarily the same point in time for all the people in the defined population (ibid, p.77).
Period prevalence refers to cases that were present at any time during a specific period of time (ibid, p.77).
Incidence is defined as the proportion of a group initially free of a condition that develops it over a given period of time. Incidence thus refers to new cases of a condition or new outcomes which occur in a population initially free of the disease or outcome (ibid, p.77).

CHAPTER 2

LITERATURE REVIEW: PRMDS

The literature related to PRMDs tends to be descriptive. Researchers in the field have surveyed and examined musicians, mostly symptomatic individuals, to establish the types of symptom and dysfunction experienced by musicians playing particular instruments and to document the prevalence of these problems. There are high levels of agreement about the types of overuse symptoms experienced by musicians. The reported prevalence of pain of varying severity is high.

Bejjani et al (1996) summarized what they considered to be the most relevant literature of the preceding 10 years concerning the musculoskeletal and neuromuscular conditions of musicians, and included some older but "fundamental" articles. They included 58 series, 9 case studies, 5 surveys, 2 pre/post intervention studies and 1 double blind crossover clinical trial. Bejjani et al wrote that the available literature did not permit a "truly critical review", as "research in the last 10 years appears not to have been done in a true blinded, random case-controlled fashion. Many authors support their statements with only their respective clinical experiences" (p.406). This assertion implies that clinical experience is a less valid form of scientific evidence, which is one of the issues challenged in this thesis.

Although randomized double-blind controlled trials (RCTs) are regarded as the "gold standard" of research design, a number of limitations exist in their use for rehabilitation research rather than medical research. For example, the RCT may not be the best tool for rehabilitation research because of the complexity of such research compared with other forms of medical research. Difficulties that have been identified include the issue of how to effectively measure subjective rehabilitation outcomes, in terms of minimising disability and optimizing function, how to assess the influence of context, and difficulties in controlling the number of variables likely to impact on the outcome. By comparison, these aspects are less problematic with medical research involving a "single organ, biochemical response or drug effect" (Andrews 1991, p.5), and where a large measurable change as the result of the intervention can be expected. For these reasons, other forms of evidence, such as single-case

design studies (which allow for complex patterns of variables to be examined deeply in context) may be more appropriate for rehabilitation studies (Andrews 1991, p.8). The bulk of the literature identified in this study that relates to musicians' injuries is based on clinicians' experience. It is likely, therefore, that there will be bias in the information presented, as these accounts are of clinical observations, not of randomized controlled trials. It is accepted that there will be information missing, particularly in relation to musicians who have not experienced a PRMD or who have successfully managed a PRMD. One of the issues related to the concept of experience is whether the experience has undergone a process of reflection, articulation and testing to convert generalized experiences into experience-based knowledge (Higgs et al 2004). Such non-propositional knowledge, called professional craft knowledge (PCK) (Higgs and Titchen 1995), particularly when it derives from professional experience tested by individuals in the field (the professional community), can become strong evidence for practice (ibid). As such, musicians' PCK can provide a basis for understanding both the nature of their injuries and their strategies to manage and "survive" them.

Although much of the research in the health and medical fields is quantitative, qualitative research methodology has gained increasing acceptance over the past 40 years in Australia in the fields of social and health sciences (Minichiello et al 1995). Qualitative methods such as in-depth interviewing facilitate "an understanding of the informants' perceptions", and are "a deliberate move away from quantification and testing of hypotheses" (Minichiello et al 1995, pp.10-11).

According to Strean (1998, p.234), qualitative research has moved beyond "trying to discover the one correct map" of the world, as it is experienced, to trying to construct a useful map and researching what that might accomplish. With regard to the field of sport psychology, Strean suggested that "perhaps the most interesting (but virtually untapped) potential area for performance-related description is thorough biographical accounts of successful coaches' and athletes' views and experiences" (p.337). He provided thought-provoking commentary regarding the "particular tragedy" that, by failing to take account of successful coaches' and athletes' experiences, valuable opportunities to capitalize on their experiences, for example by seeking to understand what they regard as important or

influential in the success of their careers, are lost. Musicians have been described as elite athletes. The usefulness of this comparison is further considered in Section 2.3.

The aim of the second study reported in this thesis is to explore the nature of playing-related musculoskeletal disorders and identify any strategies for their prevention and management via musicians' own accounts of their experiences, rather than from the perspective of treating health professionals or music educators. As discussed subsequently in this chapter, variations in individual tolerances, based on an array of factors such as anatomy and physiology, and other considerations such as motivation and practice behaviours contribute to the difficulty of predicting who is likely to be susceptible to injury (Fry 1984, Lehrer et al 1993). This suggests that a sophisticated analysis of a complex range of individual variations in both anatomy and behaviour may be required to formulate effective prevention programmes. Although there will be common elements in such programmes, consistent for example with well-established principles of exercise design, the unique aspects of the individual musician's experience must be accounted for in any such programme.

2.1 Defining PRMDs: Terminologies, misuse/overuse

Although much has been written on the variety of occupationally-related musculoskeletal problems experienced by musicians and other occupational groups, there is limited agreement on the terminology or the identifiable pathology for this group of problems. Fry (1986a) argued that there is a case for describing these presenting problems as a syndrome, with the word *injury* in brackets until muscle biopsy showed structural changes. However, this suggestion has not been taken up by the medical fraternity. One of the reasons for Fry's suggestion not being adopted could be that its merit is not clear, in terms of assisting with treatment and rehabilitation choices. Additionally, muscle biopsy is not a commonly used diagnostic tool. A variety of other terms have been used, which are explored here. The necessity for thorough assessment of the person presenting with work-related musculoskeletal injury, to attempt to identify the implicated structures, including neural pathologies, was emphasized by Hutson (1997).

Zaza and Farewell (1997, p.293) developed an operational definition for PRMDs "in the absence of objective 'gold standard' criteria for the diagnosis of PRMDs". They defined a PRMD as a medical problem identified by the individual musician, which is serious and chronic, affects a musician's capacity to play at his or her usual level, and is beyond the musician's control. This definition was developed by 27 musicians and three health professionals "in a separate qualitative study which showed that musicians clearly distinguish between mild, transient aches and pains, and a PRMD" (p.293).

Using this definition, PRMDs may be viewed as the result of interactions between physical, psychological and playing-related behavioural factors (such as taking appropriate breaks during practice sessions, using appropriate seating, and performing a musical warm-up). Thus it would seem that the complexity of the origins of a PRMD may be great. The variation in causal pathways may also result in difficulty in identification of the causal factors and thus impact on the success of treatment if only the presenting causes are addressed. As an example, mobilizing a stiff thoracic spine may result in pain relief for some time, but if the causes of the stiff spine are not identified and addressed then the problem is likely to recur.

According to Bejjani et al (1996, p.404) "the most prevalent medical problems among musicians are related to overuse or misuse stemming from the repetitive movements of playing", combined with the sustained effort of holding the instrument, often in awkward postures. Bejjani et al (p.407) adopted Fry's (1986a) definition of "overuse syndrome": "a painful condition brought about by long, hard use of a limb that is excessive for the individual affected, taking the tissues beyond their biological tolerance and causing some subsequent change". This concept seems to be generally accepted in the literature, although there is debate as to whether problems such as pain and dysfunction, result from misuse or overuse of muscles and other soft tissues such as tendons. This debate is further explored here.

Inconsistency may be observed in the terms used to describe the experiences of pain associated with playing-related musculoskeletal disorders. For example, Revak (1988) used

the term "discomfort", even though in some cases the "discomfort" was reported as being sufficiently severe to impair the ability to practise. Such inconsistencies make it difficult to compare findings.

The term "overuse syndrome" is often used generically and can refer to a wide range of conditions, including tendonitis, tenosynovitis and dystonia (Bejjani et al 1996, Zaza 1998). Some consider neuropathies to be outside this umbrella term. Mandel (1990) grouped the playing-related clinical disorders experienced by musicians into the categories of general overuse syndrome, compression and entrapment neuropathies, and focal dystonia. Common neuropathies that affect the general population are seen in many musicians, including carpal tunnel syndrome, ulnar neuropathy and thoracic outlet syndrome (Lockwood 1989).

The imprecise nature of the terms used by writers to refer to the multiplicity of presentations of work-related musculoskeletal disorders is demonstrated in the National Code of Practice for the Prevention of Occupational Overuse Syndrome, Worksafe Australia (1994). This document states that "Occupational Overuse Syndrome (OOS), also known as repetition strain injury (RSI) is a collective term for a range of conditions characterized by discomfort or persistent pain in muscles, tendons and other soft tissues, with or without physical manifestations. It is usually associated with tasks which involve:

a) repetitive or forceful movement or both; and/or
b) maintenance of constrained or awkward postures" (p.4).

It seems that this definition has been designed to exclude specific diagnoses, such as carpal tunnel syndrome, specific neuropathies, true tendonitis and inflammatory disorders, so that what remains is a diffuse collection of symptoms that may not have physical manifestations. In earlier writings, RSI was used as an umbrella term, but many writers in the field are specific about these exclusions, differentiating between overuse syndromes and these other clinical entities (Elbaum 1986, Fry 1984, 1986a, Lo Buono 2001, Lockwood 1989, Mandel 1990, Owen 1985). The usefulness of grouping a range of conditions together can be questioned, since a lack of knowledge or understanding of the underlying pathology is likely to have implications for the treatment and management strategies proposed, particularly for

conditions that present "without physical manifestations". If the underlying cause cannot be identified, how can effective and consistent treatment choices be made? Once specific diagnoses have been excluded from the umbrella diagnosis of OOS or RSI, grouping a diffuse range of signs and symptoms together under one term may also reduce the identification of risk factors which are relevant for some conditions but not others, if the underlying structures affected are not clearly identified (Zaza and Farewell 1997).

A useful grouping of these disorders was proposed by Hutson (1997, p.vii). He described two groups of work-related upper limb disorders (WRULDs), emphasising the need for careful assessment, "particularly with respect to the identification of stressors" and the impact of diagnosis on management, prevention, prognosis and litigation. Type 1 WRULDs have "relatively clear-cut clinical characteristics and established protocols", including de Quervains' tenovaginitis, carpal tunnel syndrome and lateral epicondylitis. Type 2 WRULDs are described as "a regional pain syndrome in which there is widespread dissemination of symptoms between the neck and the hand" (p.vii).

Other terms found in the literature for these conditions include cumulative trauma disorder, cervico-brachial syndromes, occupational cervicobrachial disorder, musculoskeletal occupational disorder, occupational overuse syndrome (OOS), and work-related upper limb disorders (Bejjani et al 1996, Elbaum 1986, Fry 1986a, Hutson 1997, Muggleton, et al 1999). The terminology tends to depend on the era and the country; for example, in Australia in the early 1980s the term RSI was commonly used, but in the 1990s OOS was more frequent (Hutson 1997, National Code of Practice 1994). Fjellman-Wiklund and Sundelin (1998) used the term "work related musculoskeletal disorders" (WMSDs) in their study of music teachers, and Chan et al (2000) used "playing-related musculoskeletal complaints" (PRMCs).

The inconsistency of nomenclature was also demonstrated by the 27 musicians interviewed by Zaza et al (1998) who were either classically-trained professional musicians or university music majors. They referred to PRMDs using a variety of terms relating to aspects such as diagnosis, site, injuries and problems.

Lehrer et al (1993, p.366) suggested that the term *overuse* has a positive connotation, implying that the syndrome results from "excessive physical, mental and emotional work". Thus the syndrome is perceived as resulting from working too hard. However, on the basis of their clinical work these researchers believed that *misuse* was the more appropriate term, and in their view the problem arose from contracting agonist and antagonist muscles simultaneously. The implications of diagnosis for treatment choice are highlighted by this observation. As discussed further in this chapter, the treatment recommended for overuse is rest of the injured structures. However, a diagnosis of misuse would suggest that a different treatment route would be more effective, for example muscle retraining so that only the muscles needed for the particular action are contracted. If the diagnosis of misuse is accurate, rest could be potentially detrimental, possibly resulting in disuse atrophy and also having psychological effects on the musician excluded from the workplace.

The viewpoint of Lehrer et al (1993) is at variance with the findings of other authors that two of the most identifiable causes of PRMDs are the hours of constant repetition and an increase in intensity and time of practice or performance. The possible causes of PRMDs are discussed in more detail in this chapter.

Despite the above comments, it is noted that Lehrer et al (1993) reported that the onset of the problems experienced by the musicians they studied typically commenced following the preparation of "a virtuoso piece for a major audition or a major concert and was exacerbated by practicing difficult passages at tempo" (Lehrer et al 1993, p.366). This suggests that the trigger for the reported symptoms was an increase in workload, which could be viewed as resulting in overuse of certain muscle groups.

Another example of differentiation between overuse and misuse as the cause of PRMDs is found in the writing of Hartsell and Tata (1991), who reported that when they commenced their research they believed that these painful syndromes "should be more accurately termed 'misuse' due to incorrect or improper use (of the musculoskeletal system) by the music student" (p.17). The population they surveyed, post-secondary music students in Canada, were expected to develop proficiency on more than one instrument. Regular practice on each

instrument was required, although the time spent on each instrument was not specified. Hartsell and Tata found that the greatest incidence of injury resulted from practice involving the principal instruments. This led them to conclude that "repetitious, skilful movements requiring control and coordination lead to overuse" (p.17). They had expected that the injuries might result from playing the secondary instrument, where they suggested "less skill may be evident" (p.17), thus leading to misuse injuries, for example of muscles required for both static loading and dynamic activity. However, this explanation assumes that skilled movement is synonymous with good technique, and does not account for the possibility that a skilled movement could still be a poor technique for the body dynamics of a particular individual, which might partly explain why some musicians experience PRMDs and others do not. Neither does this explanation take account of individual variations in safe and pain-free duration of use. This point is discussed in further detail subsequently in this chapter.

2.2 Playing-related musculoskeletal disorders: Types, cause and occurrence

Despite the increase in interest in the area of the performing arts medicine, both in terms of research and increasing knowledge of the types of injury and in terms of developments in available physical treatment and musician-specific clinics, the reported occurrence of PRMDs has remained constant over several years. The term *occurrence* (a more general term indicating "level of") is used in this section, except where quoting directly from other studies, as there appears to be inconsistency in the use of the statistical terms incidence and prevalence (especially) used to report musicians' injuries.

There appears to be little change in the proportion of musicians reporting injuries over the 12-year period from 1986 to 1998. For example, Fry (1986b) reported an incidence of PRMDs of 42% and Zaza (1998) 39-47% for adult musicians, once the data had been adjusted to exclude mild or transient (Grade 1) symptoms. The significance of excluding mild or transient symptoms is discussed in Section 2.2.3. These data notwithstanding, there remains a perception amongst some authors that the occurrence of PRMDs has increased over the years (Hagglund 1996, Horvath 2001).

It is noted that Fry (1986b) calculated incidence by the following method: he divided the total number of "disabled players" by the total number of players in the sample, and expressed this as a percentage. Using the definitions adopted for this thesis (Fletcher et al 1996), this calculation would be termed prevalence, rather than incidence. The issue of data reporting is examined subsequently in this chapter.

It is possible that professional musicians have increased their workloads over the last 20 years or so. In 1985 Owen reported an increase over the previous 10 years in playing schedules, recording sessions, concerts and rehearsals for professional musicians, increasing the risk of PRMD. Similar reasons were put forward 16 years later by Horvath (2001, p.2), who added "more demanding repertoire(s) and tremendously high standards" also contributed to this increase. A similar explanation for the increase in PRMDs amongst students was proposed by Hagglund (1996), who noted that the work intensity and pressure on music students to be flawless performers had resulted in a significantly increased prevalence of music-related injuries in the preceding 10 years, although this prevalence was not quantified.

Musicians need to be able to sustain long hours of playing to maintain a career. Hagglund (1996, p.139) stated, "success for a professional musician requires a virtual endless amount of time practicing and studying music", and in a like vein, Hartsell and Tata (1993, p.13) wrote that musicians "spend countless hours practicing and refining skill components". The 660 musicians and students in Larsson et al's (1993) study reported that they usually practised 4 to 5 hours per day. Similarly, Owen (1985) reported that his sample of 110 musicians with RSI-related injuries averaged 6.5 hours of playing (practice and performance) per day, with a range of 1-10 hours per day. According to Ericsson and Lehmann (1996), experts in several skill domains including music require 4 hours per day deliberate practice, with expertise becoming apparent only after some 10 years of such work-like practice.

Musicians' tasks clearly involve repetitive movements and the maintenance of constrained or awkward postures for many hours. Quarrier (1993, p.92) noted that some instruments require static and awkward positioning, and proposed that "as musicians spend hours in one position,

it is more than likely that postural fatigue contributes to injury", a view supported by Keller (2001). Most musicians start training before 10 years of age, and according to Owens (1985), although pain and discomfort are reported by younger players, it is common to find a pattern of pain emerging, particularly in violinists, after about 20 years of practice and performance. This accords with the assertion by Slade et al (1999) that the injury rate in musicians generally peaks in their third and fourth decades. It is also plausible that age-related degenerative skeletal changes, such as osteo-arthritis, have an impact on pain reporting in this age group, although no publications related to this point were identified.

Comparison of injuries amongst other groups using repeated hand and finger movements, such as computer data-entry personnel, would suggest that occupational overuse might be identified as the main cause of playing-related injuries, amongst string players in particular. This viewpoint was supported by Zaza and Farewell (1997, p.293), who noted that "musculoskeletal conditions which disable musicians are also prevalent in workers in other occupations". This view was also supported by Bejjani at al (1996), Elbaum (1986), and Lo Buono (2001).

Although overuse has been identified as the cause of PRMDs by many authors, it was not readily and universally identified as the principal cause of injury by musicians themselves (Zaza et al 1998). As the aim in this thesis is to explore musicians' perceptions about their injuries and any strategies they might use to prevent or mitigate the effects of playing-related injuries, the term *playing-related musculoskeletal disorder*, rather than overuse or misuse, is used throughout, except where other authors' work is quoted.

2.2.1 Types of injury

There is general agreement that the patterns of PRMD which musicians experience are related to the size, weight, and playing position of their instruments and to the particular technical demands associated with the required repertoire, such as intensive practice of difficult passages and short preparation time-frames leading to intensive practice sessions (Bejjani et al 1996, Bird 1989, Elbaum 1986, Eller et al 1992, Fishbein et al 1988, Fjellman-Wiklund and Sundelin 1998, Fry 1984, Hartsell and Tata 1991, Keller 2001, Kivimaki and Jokinen 1994, Lockwood 1989, Mandel 1990, Nagai and Eng 1992, Owen 1985, Palac 1995,

Quarrier 1993, Zetterberg et al 1998). The body areas affected are "representative of the static and dynamic loading requirements of the various instruments" (Hartsell and Tata 1991, p.13). The prevalence of many of the PRMDs experienced by musicians differs according to gender and age. Women are generally reported to experience a higher rate of injury, particularly those playing larger instruments such as viola and cello (Eller et al 1992, Fishbein 1988, Fry 1984, 1987, Larsson et al 1993, Lockwood 1988, Revak 1989, Slade et al 1999, Zaza and Farewell 1997). Slade et al (1999, p.543) considered that the higher rate of injury for women "is often hard to understand, because women are not uniformly represented (in all sections) in the orchestra". This comment indicates an expectation that males and females would experience the same musculoskeletal stresses from playing the same instrument, regardless of well-documented gender differences in factors that might be relevant to physical tolerance, such as strength and muscle-to-fat ratio. No further information regarding this viewpoint was identified in the literature.

In a study of 379 musicians with "painful overuse syndrome", Fry (1986a) reported that pain was the dominant symptom of PRMD, and that "the patients invariably felt depressed" (p.183). Fry assessed approximately 900 musicians, and included only those with signs and symptoms of "overuse syndrome" in the study. These musicians were drawn from members of six symphony orchestras and the staff and students from nine music schools. In addition to pain, other symptoms reported include local tenderness, weakness, loss of co-ordination, cramping, burning sensations, sensory changes, and spinal pain. The signs of overuse syndrome reported included weakness, loss of response (diminished agility and speed) or loss of movement control (diminished accuracy). For musicians, these symptoms result in diminished technique. Non-musculoskeletal injuries reported amongst professional musicians have included hearing impairments, stage fright and psychological problems (Elbaum 1986, Fry1984, 1986a, 1986b, 1986c, 1987, Hartsell and Tata 1991, Lockwood 1988, Mandel 1990).

Examples of overuse injuries experienced by musicians include: problems with the wrists and hands in pianists; shoulder, neck, elbows wrists and hands in string players; right shoulder problems for flautists; and low back problems in cello and double bass players. Overuse has

been considered to develop arising from the static loading of the first web space (that is, between the thumb and index finger) muscles used to support instruments such as the clarinet, oboe and English horn and of the carpometacarpal and metacarpophalageal joints of the right thumb in these players. Wind players are prone to tempero-mandibular joint dysfunction and malocclusion of the jaws. Violin and viola players may also develop tempero-mandibular problems because of prolonged holding of the instrument between chin and shoulder (Elbaum 1986, Fishbein et al 1998, Fry 1984, Lockwood 1989, Nagai and Eng 1992, Owen 1985). Papsin et al (1996) reported on 10 brass players who presented between 1985 and 1992 with injury to the orbicularis oris muscle. They stated that this injury usually occurred when players changed mouthpieces or played at the limits of register or intensity; that is, the injury could be acute or the result of prolonged stress of the involved muscles and soft tissues.

2.2.2 Cause

As previously discussed, the aetiology of PRMD has not been well established, and this deficit is partly due to the use of different terms to cover many pathologies and presentations. Whereas the underlying pathology of neural entrapments is well described, for example by Lockwood (1989), the pathologies that might result in the diverse range of symptoms classified as occupational overuse injury are not clearly described in the literature surveyed. This is probably attributable to the complex interaction of the many underlying anatomical structures which might be implicated. The following section details both the proposed underlying pathologies that might account for some of the symptoms reported and the overt activities that some authors have proposed as the cause of overuse syndromes.

Specific diagnosis is essential for appropriate and effective choices in relation to many therapeutic strategies, including surgery. The prognosis and management of PRMDs may vary considerably, depending on the diagnosis (Hutson 1997). However, diagnosis is not always straightforward, in which case some interventions, such as physiotherapy, revert to the management of symptoms and functional disorders rather than specific pathologies.

Some recent research on focal dystonia offers an interesting insight into the complexity of the task of determining the underlying pathologies associated with PRMDs. A number of

different terms are used in the literature for focal dystonias, including occupational cramps, musician's cramp and writer's cramp (Charness et al 1996, Hutson 1997, Lockwood 1989, Priori et al 2001). A focal dystonia is defined as a cramp-like injury of unknown pathology "provoked by highly rehearsed, repetitive activities, such as writing or playing a musical instrument" (Charness at al 1996, p.431). Musicians may be more susceptible to developing focal dystonia than the general population; the condition is difficult to treat and may terminate or drastically alter a career (Lockwood 1989). Diagnosis requires a clear description of the symptoms and symptom behaviour by the musician, observation of the motor dysfunction by the medical practitioner and exclusion of other neuromuscular abnormalities (Hutson 1997). The condition in musicians is often associated with repetitive movements and over-training (Hutson 1997). However, according to Priori et al (2001) there is no definitive evidence for a causal relationship between focal dystonia and these factors. This lack of identification of the precipitating factors has implications for the ability of the treating professional to determine appropriate treatment and prevention strategies.

The multitude of therapeutic strategies frequently used for this condition reinforces "the lack of understanding of the pathophysiology" (Hutson 1997, p.91). This point is illustrated by a case study of focal dystonia in a musician, presented by Kember (1997), who wrote that focal dystonia "presents as an uncontrolled movement which interferes with the highly skilled co-ordination necessary for playing an instrument" (p.221). The condition is painless, unless the person with the condition attempts to actively "override the problem by using joints and soft tissues in abnormal postures" (ibid, p.223). The condition presents only when the sufferer attempts "to use a specific motor skill, e.g. playing, and usually affects no other activities of daily living" (ibid, p.223). Typical presentations include a) a pianist with flexion of the right fourth and fifth fingers so that the fingers cannot clear the keyboard, b) a classical guitarist with right third finger flexion, and c) a clarinetist with right third finger extension preventing covering of the keys. All of the cases Kember treated were screened clinically for predisposing conditions that might cause dystonia, such as central nervous system pathology. Kember detailed a treatment protocol, but added that the prognosis was unpredictable, with recovery taking 6 months to 2-5 years.

In response to Kember's report, Friedman (1998) drew attention to two experimental research studies demonstrating the neurophysiological basis for focal dystonia, which used four different monkeys, two in each study. The results, based on measurements of movement accuracy, speed and efficiency, and electrophysiological mapping of the cerebral cortex, suggested that the analogue of OOS created in monkeys was more than a simple biomechanical problem, as cortical changes were demonstrated. Task variation was recommended for avoiding human focal dystonia and OOS. Task variation is now a common occupational health and safety recommendation for workplaces which involve stereotypical movements, such as certain factory situations. For a musician, instituting task variation could be interpreted as taking appropriate breaks during practice sessions, that is, breaks that do not involve upper-limb activities.

A limited number of publications describe normal muscle response to playing, and pain free technique. Of the few recent studies, Wilkinson and Grimmer (2001) and Turner-Stokes and Reid (1999) have investigated these aspects. Prior to these studies, Hagberg (1981) demonstrated fatigue in four upper-arm muscles: trapezius, supraspinatus, infraspinatus and biceps, via electromyographic studies with seven subjects. The arm was held in two different elevated positions, 90 degrees of forward elevation and 90 degrees of abduction. The subjects were asked to maintain the position for as long as possible, and each subject took part in only one experiment per 24 hour period. The researchers concluded that in elevated arm positions fatigue develops rapidly, and for some muscles EMG muscular fatigue was evident in less than 1 minute. Supraspinatus and the upper part of trapezius showed signs of fatigue in both positions after 5 minutes. These muscles play a significant role in violin and viola playing. Although the effects of physical training on increasing human physical capacity have been well documented (Genaidy et al 1992), it is not known what effect training has on the endurance of the abovementioned muscles and the onset of fatigue, in relation to violin and viola playing. However, Hagberg's (1981) study points to a possible source of problems for these players, that is, sustained arm elevation.

Hagberg's (1981) research was cited by Marshall and Clare (1987), who proposed several possible causes of pain, based on this and other clinical research including EMG studies and

research on the production of pain in the neck and upper arm by stimulation of cervical discs and surrounding ligaments. Thus possible sources of pain related to playing the violin or viola could include muscle fatigue or irritation of cervical disc and surrounding tissue.

A potential mechanism for injury in violinists and viola players was suggested by Wilkinson and Grimmer (2001). They conducted a pilot study using ultrasound to assess the reaction to performance of the left shoulder girdle muscles of 15 elite violin and viola players. The subjects were used as their own controls. Control measures in this study were obtained when no performance or major rehearsal had occurred for more than 72 hours. Repeated measurements were then taken at 12, 18, 24, 36 and 48 hours after performing. The aim was to assess whether ultrasound was an effective method of substantiating changes in muscle after workload and the return to pre-activity state over time. The soft tissues assessed were those involved in static holding of the instruments. They were the tendon of the long head of biceps, the tendon of the supraspinatus muscle, the upper portion of the trapezius muscle, the middle portion of the trapezius muscle and the lateral rhomboid muscle.

Wilkinson and Grimmer (2001) argued that muscles in this group are active repeatedly at low forces relative to their maximum strength during music performance. They referred to previous findings from Sjogaard and Sogaard (1998), that sustained low-intensity muscle activity for long periods may be the cause of muscle fibre necrosis (Sjogaard and Sogaard 1998, cited in Wilkinson and Grimmer 2001). The implication for violin and viola players therefore is that this type of activity, which is central to their music-making, could place them at risk of injury.

Wilkinson and Grimmer (2001) found that significant increases occurred in the size of the tendon of the long head of biceps at 12, 18, and 24 hours after playing, when compared to baseline measurements. A significant increase was also found in the size of the upper trapezius muscle at 12 and 18 hours, with a trend towards significance in all other time frames, and for the middle trapezius muscle, medially at 12 and 18 hours, and laterally at 12 hours. Neither the supraspinatus tendon nor the lateral rhomboid muscle showed significant increase in any time frames. The authors concluded that the findings pointed to the need for

baseline data on healthy shoulder muscles under the above condition, that is, long duration, low intensity, sustained muscle activity, in order to establish normal muscle response to this activity, as it is not known at this time how much size increase is sustainable over longer periods before injury occurs.

Another example of recent research into the mechanics of playing music is a motion analysis study of the three-dimensional upper limb movements in the bowing arms of 39 asymptomatic string players with advanced technique (Turner-Stokes and Reid 1999). The subjects were 20 violinists, 7 violists and 12 cellists. Having developed and tested the protocol using a MacReflex 3-D analysis system, Turner-Stokes and Reid assessed the musicians. They concluded that the system gave reproducible results and demonstrated clear differences in style and technique between the musicians for each instrument. They also concluded that further study was needed to establish whether three-dimensional analysis might be useful in the diagnosis of different musculoskeletal syndromes in string players, or in identifying movement patterns that might exacerbate repetitive strain injuries.

EMG studies of the upper trapezius muscles of 14 professional violin players were conducted before and after training sessions lasting from 2 to 3 hours, in a study by Chan et al (2000). Eleven of the subjects reported having pre-existing PRMDs, with eight requiring rest and/or medical advice to ease the symptoms. No significant difference was demonstrated in the pre- and post-training EMG studies. Nonetheless, analysis of the pre- and post-training Borg[2] scale of the rate of perceived exertion indicated that the violinists perceived significantly more exertion after practice.

Chan et al (2000) suggested that the lack of fatigue in the trapezius muscles post-training might be related to the observed nature of that training. That is, because the session did not consist of continuous or prolonged playing the players may not have reached sufficient workload levels to result in physiological fatigue. The increase in exertion perceived by the

[2] The 10-point Borg scale is a self-reported measure, also referred to as the Category Ratio (CR-10) scale, in which participants rate their perceived effort in relation to task performance (Borg 1990).

violinists could be related to other factors, considering that the Borg scale used was not designed to measure localised fatigue at a specific site (Chan et al 2000).

While attempts have been made to identify the pathological responses that result in the symptoms experienced by musicians, other authors have considered the overt behaviours that might result in PRMD. According to Lockwood (1989, p.222), "the hours of constant repetition during intense practice are the most critical factor leading to the development of the syndrome". This view was supported by Mandel (1990), who also included stressful competition and the pursuit of perfection as factors potentially contributing to the development of PRMD. Other causes identified in the literature as common predisposing factors related to music-related injury include fatigue, playing posture, lack of knowledge and employment of proper practice techniques, lack of physical education and physical fitness (Fry 1986c, Hagglund 1996, Hartsell and Tata 1991).

Three factors which contribute to the likelihood of a student developing overuse syndrome were identified by Fry (1986a) as: the genetic factors which contribute to individual robustness, technique, and an increase in intensity and time of practice or playing. In Fry's opinion, overuse injuries amongst student musicians might be caused by excessive, undisciplined, or sporadic practice, or the failure to properly graduate the playing times to full load (Fry 1984). Marshall and Clare (1987) found that the mean daily playing time for violin and viola players with pain was 4.6 hours per day, and for those without 1.8 hours. Other authors have identified a range of factors contributing to PRMD, including long daily practice and playing sessions, competitive pressures, exhaustive travel schedules, heavy awkward-shaped instruments and poor playing posture (Bejjani et al 1996, Horvath 2001, Keller 2001, Lockwood 1989, Zaza and Farewell 1987).

Apart from factors that can be controlled by the individual musician, such as practice session length and frequency, there are intrinsic factors that may impinge on the individual's ability to play for extended or periods of time. Various individual anatomical and physiological attributes, such as differences "inherent in the qualities of the nervous system and in the properties of skeletal muscle, such as the rate at which muscles can generate force" (Sparrow

and Newell 1998, p.176) may act to constrain movement economy or efficiency. Other examples include mechanical differences, such as the point of muscle insertion relative to joint centre or relative length of limb centre. These constraints must be accommodated rather than overcome, in order to adapt motor patterns (Sparrow and Newell 1998, p.177). In earlier work, the notion that it is not possible to predict just who will suffer (physical) breakdown under an increased workload was proposed by Fry (1984, p.60), who argued, "while the genetic weakness must exist, it cannot be recognised in advance". Similarly, Lehrer et al (1993, p.367) were of the opinion that "the nature of the damage may depend on anatomical differences between individuals and these differences determine susceptibility". These viewpoints imply that all musicians should take seriously the risk of developing PRMD, because it cannot be foretold who will be affected.

The possibility of a link between excessive muscle tension and PRMD has been raised by a number of researchers. Philipson et al (1990) assessed nine professional violinists, five of whom had experienced PRMD and four who were asymptomatic. They found that the violinists who reported shoulder and neck problems had a higher mean loading of the trapezius, right deltoid and right biceps muscles during a selection of performances than those without problems. Philipson et al (1990) suggested that this finding might be accounted for by the ability of the different musicians to relax during short pauses and individual levels of muscle tension during work. Further discussion of the possible relationship between levels of muscle tension and the prevention or mitigation of PRMDs is to be found later in this chapter.

Poor seating is frequently cited as a possible factor in the chain of events that results in PRMD (Horvath 2001, Kelnar et al 1995, Owen 1985). Classical musicians may compensate for poorly designed seats and overcrowding in the performance arena, such as the orchestra pit, by changing their playing technique, which could result in long term pain. Poor seating can also restrict the abdominal muscles and the diaphragm from moving through full range, affecting the performance of brass and wind players. The thoracic rotation necessary for holding and playing horn, flute and bassoon may be restricted by a wide or over-curved chair back. In a large study of 14 opera, symphony, philharmonic and chamber orchestras in the

USA and UK, Kelnar et al (1995) concluded that there was widespread dissatisfaction with existing seating among the majority of orchestral musicians.

Musicians are often viewed as, and indeed expected to be, stoics with regard to enduring high work loads, poor environmental conditions and pain levels (Lockwood 1989, Owen 1985). The philosophical stance of stoicism is that one must accept one's fate with indifference, even if suffering is involved. In general terms, to do so with courage is most admirable (Hergenhahn 1997). In musicians, however, this attitude may result in a reluctance to complain about even severe continuous pain and disability, with subsequent chronic injury resulting. Owen (1985) noted that referrals for RSI-related injuries were often made late in the disease process, due to the typical stoicism of musicians.

A tacit theme of personal blame or fault for the occurrence of a PRMD was identified in the responses of the musicians interviewed by Zaza et al (1998). They blamed themselves for individual music-related factors, such as technique, posture and practice habits, rather than complaining of external factors such as occupational and industrial conditions. The fear that the individual musician had done "something terribly wrong", or had in some way failed, resulting in pain and fear of real or imaginary stigmas associated with injury, was reported by Horvath (2001, p.1) as something "we (musicians) were all afraid of" in the 1980s.

The belief that the individual is solely responsible for his or her predicament is called the "just-world" hypothesis (Stein 1973). According to this hypothesis, people need to believe that there is a direct relationship between their actions and resulting outcomes. Goals can be achieved and unpleasantness avoided by appropriate effort and skill. Conversely, someone who suffers misfortune is believed by others to have behaved in such a way that he or she is deserving of that misfortunate outcome. This belief allows us to avoid the unpleasant notion that misfortune can befall us all, despite our adhering to perceived appropriate behaviours (Stein 1973). The relevance of this hypothesis to musicians is that placing the onus for injury solely on the individual may result in other factors such as working conditions remaining unexamined, thus reducing the likelihood of recovery if those factors are part of the cause.

Instead it is necessary to examine both player and contextual factors, to identify contributing and treatable causes.

On the basis of the available literature it would seem that certain clinical entities in the general population and in musicians can be reliably diagnosed. After these have been excluded there remains a diffuse collection of symptoms which may be severe enough to be disabling for the musician. As the structures and pathologies causing these symptoms are not well understood, it is reasonable to suggest that there is likely to be a wide variation in the types of preventive advice and treatment protocols offered to musicians, depending on the knowledge and experience of the health/medical practitioner involved.

2.2.3 Occurrence

The term *occurrence* rather than other statistical terms such as incidence or prevalence is used here, except where quoting other authors' works, for the following reasons. Although there are many studies of the occurrence of PRMD it is difficult to form an accurate picture of the size of the problem because of the variation in terminology and the ways in which data were collected and reported. Despite the many available studies, Zaza (1998) has stated that little is known about the magnitude of the health problems of musicians, the factors that place musicians at risk, the therapies that are effective and appropriate for musicians and the ways in which musicians can prevent those problems. One of the factors which may affect data accuracy is the low questionnaire return rates often reported, linked to the possibility that the musicians who respond to research questionnaires may be those who have experienced a PRMD, and therefore data about non-injured musicians are not captured. As shown in Table 2.1, the return rate for research using questionnaires has varied from 31% to 55%. The low return rate raises the issue of bias and data validity; that is, the samples may have been skewed towards musicians with particular experiences of PRMD. Additionally, Fishbein et al (1988) commented that musicians with severe problems might drop out of the profession if they are no longer able to perform, and thus the true extent of the problem would be masked as they would no longer be in the populations studied.

Researcher	Year	Number of musicians	Type of musician (professional/ student/amateur)	Findings
Fry	1984	Not stated	4 symphony orchestras; 5 tertiary music schools	Interim report, including recommendations designed to lower "very high rate of overuse injury"
Owen	1985	110	students, "famous, mature soloists"	86% reported pain
Fry	1986a	900 assessed in total, 379 with RSI	6 symphony orchestras; 9 music schools; other direct referrals	Overuse syndromes affected all sections, reporting ranged from 47.8% (strings) to 4.2% (percussion)
Fry	1986b	485	7 orchestras: all members; 1 orchestra: many members	Gross incidence: 64% reported painful OOS; reduced to 42% when Grade 1 (transient) symptoms eliminated
Fry	1987	Students	7 Australian performing music schools	9-21% prevalence of overuse (injury) syndrome
Marshall and Clare	1987	85	violin & viola, 1x/wk-several hours/day (amateur & professional)	83.5% experienced pain
Fishbein et al	1988	2212 out of 4025 responded (55%)	ICOSM	76% had at least one medical problem severe enough to affect performance
Fjellman-Wiklund and Sundelin	1988 to 1996	1988:61 1996:36	Full- and part-time employed music teachers	1988: 88% reported discomfort (aches and pain during the preceding 12 months) 1996: 92%
Revak	1988	232 questionnaires distributed (31% response)	Piano major students	42% experienced discomfort (undefined) persisting or recurring for more than one week
Mandel	1990	3 case studies	piano student, professional violinist, amateur banjo player	Opinion: overuse syndrome can be prevented by reducing repetitiveness, forcefulness, awkward positioning, mechanical stresses
Hartsell and Tata	1991	300 questionnaires distributed 122 returned (41%)	undergraduate music students	22% incidence of injury
Eller et al	1992	91 51	instrumentalists opera singers	Female violin or viola players: particularly high frequency of arm pain (unquantified)
Kivimaki and Jokinen	1994	Questionnaire 93 responded (50%)	symphony orchestra	47% reported neck and shoulder pains
Charness et al	1996	73 cases of focal dystonia in 69 musicians		High prevalence of ulnar neuropathy in musicians with focal dystonia
Zetterberg et al	1998	227	university music students	89% reported some type of bodily pain in the prior 12 months; approximately 50% of subjects assigned cause of pain to musical activity
Priori et al	2001	7 1	male musicians female non-musician	Splint immobilisation effective in reducing focal upper-limb dystonia in 7/8 with 24 week follow up

Table 2.1 Samples of research into PRMDs: causes, occurrence, treatment.

The issue of accuracy in the published reports of the occurrence of PRMD was explored by Zaza (1998), who conducted a systematic review which addressed the reported incidence and prevalence of PRMDs in classically trained musicians. This research highlighted the difficulty in obtaining precise data on the topic. According to Zaza, the earlier published narrative reviews of the literature lacked a critical evaluation of primary studies, with one (Bejjani et al 1996) not being comprehensive, and the other (Harman 1982) being published before most of the prevalence studies were conducted. Other problems she identified in the available literature included reporting of prevalence as incidence, lack of systematic interview and examination, and lack of rigorous statistical analysis.

The inclusion criteria in Zaza's (1998) study accepted those studies which had a response rate greater than 60%, where point prevalence was provided and the data had been collected using systematic methods. This narrowed the field of acceptable articles to 18. Ten of these were critically evaluated as being ineligible for data synthesis, that is, they had significant methodological problems such as a "erroneous reporting of prevalence as incidence" (p.1021), lack of statistical significance testing, failure to clearly describe the number of musicians surveyed or the observed outcome, or whether non-playing related injuries had been excluded from the data.

Of the remaining eight eligible studies, one reported incidence and seven reported point prevalence. The prevalence for PRMD of any severity in these studies ranged from 39% to 87% in adult musicians and from 34% to 62% in secondary school music students. Only three of the eligible studies excluded mild complaints. The exclusion of mild, transient symptoms reduced the prevalence range to 39%-47% among adults, and 17% among secondary school students.

This review led Zaza (1998) to the conclusion that "including mild, short lived aches and pains results in inflated estimates of prevalence and misleading conclusions" (p.1023). Reiterating her earlier work, Zaza stated that musicians clearly distinguish between PRMD

and transient symptoms, "which indicates that even if researchers consider mild symptoms as PRMDs, musicians do not" (p.1023).

This point had been earlier demonstrated by Fry (1986b), who found that the incidence of 64% of painful overuse syndrome reported by the full complement of members of three Australian symphony orchestras, one Australian "pit" orchestra, three American orchestras, and a portion of an English orchestra, was reduced to 42% when "Grade 1 overuse is excluded" (p.51). Fry's grading system included Grades 1–5, which were defined in terms of number and severity of pain sites, weakness and loss of control, muscular response and dexterity in the fingers, and the impact on daily functional activities. In the context of musicians' injuries, Grade 1 was defined as "pain in one site on playing. This must be consistent rather than occasional, and pain ceases when the musician stops playing" (p.51). Grade 1 thus equates to the mild, transient aches and pains referred to by Zaza (1998). The grading for this classification was consistent throughout the literature (Bird 1989, Fry 1986a, 1986b, 1986c, Paull and Harrison, 1997).

Taking the above issues into consideration, the other literature reviewed for this current study is presented in summary form in Table 1.1, indicatnig the type of study undertaken, the population used and the outcomes. Review articles have not been included; only publications derived from primary data are listed. Excluding the work of Fry (1986b, 1987) and Zaza (1998), these studies have consistently reported a high occurrence of PRMDs, ranging from 22% (Hartsell and Tata, 1991) to 92% (Fjellman-Wiklund and Sundelin, 1998). However, the magnitude of the problem is not clear from the literature, because of the inclusion in the statistics of pain which musicians themselves may not have regarded as significant in terms of interfering with their ability to continue a playing career. This summary illustrates the lack of consistency in the published findings. Further, as discussed above, the severity of the PRMD studied was not always indicated.

The extent of variation in reporting PRMD is demonstrated by consideration of the following examples. Fry (1986a) examined approximately 900 musicians from six symphony orchestras, students and staff of nine music schools, and other musicians directly referred to

him. One third were students, two thirds performers. Of these musicians, 379 reported symptoms and signs of overuse. Overuse syndrome was reported in string players (47.8%), woodwind (26.9%), keyboard (26.9%) and percussion (4.2%), with some overlap in figures as some students learned more than one instrument.

A second example of variation in PRMD reported is a retrospective study conducted by Hartsell and Tata (1991). In 1989 they distributed to all undergraduate music students at the University of Western Ontario a survey questionnaire seeking information on personal characteristics, instrumentation, playing habits and injury characteristics. Of the 300 distributed, only 122 were returned. Of these, 66 reported having a music-related problem. They reported the incidence of injury as 22%, which, as the researchers pointed out, is considerably higher than Fry's (1986a) reporting of 9.3% in Australian music school students. They postulated that this difference might be attributable to a number of factors, such as their inclusion of problems that had occurred in the 5 years prior to their study whereas Fry's inclusion criteria on this point was unknown. They also pointed out that Fry's data derived from a full sample, whereas they could not comment on the 178 students who did not return the questionnaire.

A third example is a large scale study conducted by Fishbein et al (1988), yielding responses from 2212 professional musicians employed by 47 American orchestras. The response rate was 55%. Shoulder, neck and back problems were identified by many of the musicians. Non-musculo-skeletal injuries or problems identified included stage fright, eyestrain, and psychological problems such as depression and anxiety. Specific data were presented for stage fright and musculo-skeletal problems of the left hand. According to Fishbein et al, the findings suggested a relationship between the aetiology of problems arising in the left hand and the instrument group. Severe problems were reported by 12% of string players, 7% of woodwind players and 2% of brass players.

A further example of the variation in reporting on aspects of PRMD is another large scale study of musicians by Larsson et al (1993), who examined joint hypermobility to assess whether it had any bearing on work-related injury rates. Joint hypermobility was defined as a

range of motion in excess of normal. It is also known as joint laxity, and has a prevalence of 5-25% in the general population, varying with race and gender and diminishing with age (Grahame 1993). Larsson et al interviewed 660 student and staff members at the Eastman School of Music (Rochester, New York), 300 women and 360 men. Of these subjects 575 were musicians, with virtually all orchestral instruments being represented, and 85 were voice students. The participants repesented 85% of the students and 69% of the staff. A 53-item questionnaire was used at interview, to elicit information regarding the musical instruments played, the duration and intensity of musical activity, and the nature of any musculo-skeletal symptoms experienced while attending music school. Information about the frequency, location and severity of musculoskeletal symptoms such as pain, cramps, weakness, stiffness and redness was sought. The joints of each subject were assessed using a modified Carter-Wilkinson protocol, which involved hypermobility criteria for the wrists, thumbs, elbows, knees and trunk. Larsson et al concluded that in musicians, "hypermobility of joints undergoing repetitive motion is an asset but hypermobility of joints giving support is a liability" (p.1082).

As alternative interpretations of pain are possible, I here briefly present one example of an alternative explanation, as the focus of this thesis is the prevention and management of the physical symptoms which are referred to as PRMD.

The interplay between physical and psychological factors in relation to injury has been acknowledged by a number of authors (Mandel 1990, Norris 1996, Slade et al 1999). For example, Mandel recommended that in addition to the physical assessment of an injured musician, psychological assessment should be considered for the pain component, depression and secondary gain. Norris (p.90) argued that injured musicians may need psychological counselling when returning to full music making activities "to avoid the despair which can accompany set backs, treatment failure and career abandonment".

The proposition of a primary psychological condition as the cause of the symptom with which injured musicians presented was not supported by Fry (1986c, 1987), even though he had noted concurrent psychological symptoms such as depression. His reason for this opinion

was that the psychological symptoms exhibited by students with overuse syndrome largely disappeared as the students recovered.

The multiple meanings of pain and injuries for musicians, "addressing issues of motivation, emotion, and personality development and not just pathophysiology", were explored by Nagel (1998, p.84). Nagel disagreed with Lockwood's (1998, p.225) assertion that "complaints of purely psychic origin are very unusual". She reported on the course of psychotherapy undertaken by one musician who originally consulted her for problems with stage fright interfering with her performance. During the course of therapy, this musician developed physical pain. The course of psychotherapy involved four sessions per week, over a 3-year period. According to Nagel, this violinist's psychological issues were powerful determinants of her physical pain, "contrary to Lockwood's disclaimer about emotional origins of the physical complaints of performers" (p.94). It is certainly not clear from Nagel's report, however, that Lockwood's statement that complaints from such a source "are very unusual", is inaccurate. The violinist left therapy before its conclusion and it is probably fair to comment that the financial and time costs of such extended therapy would make its use prohibitive for most musicians.

2.3 Comparison between musicians and athletes: Usefulness and limitations of the analogy.

Musicians are frequently referred to in the literature as being, or being like, elite athletes, because of the similar demands of their respective professions (Harste 1990, Lockwood 1990, Pacelli 1989, Paull and Harrison 1997, Quarrier 1993, Slade et al 1999). These demands include strength, flexibility, coordination, and agility, "all which are components of a true athlete" (Quarrier 1993, p.90).

Lockwood (1990) wrote that "musicians don't like to be compared with athletes", but noted that both groups are involved in activities requiring a great deal of training, and this makes them susceptible to injury and disability (quoted in Harste 1990, p.10). Similarly, Elbaum (1986) explained that there are many similarities between the performing musician and the professional athlete. They perform publicly in highly competitive fields, and their economic success is dependent upon their level of skill at any given time. Both groups demand peak

levels of performance in fields where physical skills determine level of success. Elbaum pointed out that despite similarities the two groups are not subject to the same type of musculoskeletal problems: athletic injuries tend to be acute, while musicians suffer microtrauma over a long period of time, a view supported by Slade et al (1999).

Despite being somewhat comparable to elite athletes, musicians have needs which are unique to their profession (Harste 1990). Elbaum (1980) noted that whereas athletes are judged on their actual physical performance, musicians are judged on the depth of musical expression; that is, the skills are only a precursor to success. The age at which the two groups reach peak performance is different. Athletes generally peak in young adulthood, whereas musicians peak in middle age.

The similarities between these two groups allows the inference that preventive advice and treatment regimes used for elite athletes could be applicable to musicians. Further, Nagai and Eng (1992) noted that the goals in rehabilitating musicians are similar to those for sports injuries, such as returning the patient to maximum performance. The point can be made that one of the goals of rehabilitation for any injured person is optimization of function. However, for elite groups, such as professional musicians and athletes operating in a competitive environment, the standards required for continued success and employment are exacting.

There are clearly similarities between the two professional groups, including the high number of hours of training required to produce a peak performance in either field. However, there is one major difference between careers in these two fields: musicians expect to have a career spanning many more decades than most professional athletes. Therefore the long-term preservation of physical capabilities is paramount. This includes the prevention of playing-related injuries and the maintenance of optimal physical condition. So musicians might be expected to be taking very seriously the issue of a career-ending injury and the task of planning and carrying out a long-term prevention strategy.

It has been suggested that athletes with relatively serious injuries may be able to return to amateur competition if they are able to "coast", that is, to play within their injury-imposed

limitations. They may also take longer to return to participation if there is no financial pressure to return to play. Thus return to play may be considered as a multicausal construct, influenced by factors such as motivation, peer pressure, level of competition and financial constraints, in addition to the recovery from the physical injury (Alonso et al 1998). On the other hand, Norris (1996) identified a possible negative response by other orchestral members, who may consider that an injured musician seeking gradual return to work is being favoured with an easier schedule. The implication for professional musicians, for whom coasting is not a readily available option, is that the other factors such as financial and peer pressure may lead them to attempt to return to work earlier than is advisable in terms of adequate recovery time.

2.4 Musicians as expert performers

Professional musicians need to become expert performers in order to sustain a successful career. Ericsson and Lehmann (1996) define expert performance as consistently superior performance on a specified set of representative tasks for a skill domain. One of the characteristics of expert performers is the ability to reliably display their superior performance upon demand. To do so they must master all relevant factors, such as domain-specific cognitive and perceptual-motor skills, and must sustain the motivation to continue deliberately engaging in the consistent long-term practice required to achieve expert performance.

The concepts of control and co-ordination are central to discussions of skill execution, with an improvement in goal achievement resulting from an improvement in either or both. *Control* relates to "the absolute magnitude of the limb or limb segment movement" (Sparrow and Newell 1998, p.176). It can be described in terms of properties such as the amplitude, velocity or force of movement. *Coordination* can be defined as the relationship between the movements of different segments of the same limb (intra-limb coordination), or the relationship between the movements of different limbs (inter-limb coordination) (Sparrow and Newell 1998).

Successful musicians must develop high degrees of coordination and accurate fine motor skills which can be reliably sustained over prolonged periods of time, both for discrete

performances and over the span of their career. The literature relating to economy of movement, or efficiency, or least effort was reviewed by Sparrow and Newell (1998). They explored the evidence which supports the hypothesis "that metabolic energy regulation is a fundamental principle underlying the learning and control of motor skills" (p.174), rather than a by-product of increased motor task proficiency.

Efficiency of movement can be defined as the ratio of mechanical work done to the metabolic energy expended. A number of difficulties in using this calculation were discussed by Sparrow and Newell (1998), relating broadly to the measurement of the mechanical work done in performing motor tasks, and particularly to the problem of accounting for the way the limbs are moved. This analysis led to the development of linked segment models. This type of model allows analysis of efficiency in terms of the refinement of limb movements. Sparrow and Newell asserted that the term *economy* is more useful than *efficiency* in discussing everyday motor skills, because of the difficulties associated with accurate measurement of the amount of mechanical work preformed. Thus it could be proposed that expert musicians need to develop an economy of movement regarding their playing skills in order most effectively to sustain both the motivation and the physical capacity required for the hours of practice needed to reach the expert performer level.

According to Ericsson and Lehmann (1996), expert performers often start training at very young ages. They engage in sustained training, of which the intensity and duration "far exceeds the range for other activities pursued by individuals in the normal population" (p.274). As previously noted, most musicians begin serious musical studies at an early age, on average at about 8 years of age (Owens 1985).

Based on their earlier work, Ericsson and Lehmann (1996) stated that experts in several domains engage in deliberate practice for about 4 hours per day. This seems to be the maximum amount of fully concentrated training that can be sustained on a daily basis for many years, without leading to exhaustion and burn-out (Ericsson and Lehmann 1996). About 10 years of intense, deliberate preparation is required to become expert in different domains, and considerably longer for international-level performance.

Peak performance for experts is attained at different ages. For vigorous sports, the age distribution is narrow, usually in the 20s, and exhibits "systematic differences across different sports and activities with a given sport" (Ericsson and Lehmann 1996, p.277). For creative achievements, peak performance falls most frequently in the 30s and 40s, a view also supported by Slade et al (1999).

There is a popular perception that musical talent is a pre-requisite for excellence or expert performance as a musician. For example, Quarrier (1993, p.91) stated that "in order to play an instrument, strength, flexibility, endurance, coordination, and talent or ability are also required". Howe et al (1998) conducted a comprehensive review of the arguments and evidence for and against the assumption that talent is innate. They reviewed about 260 articles on the topic, and concluded that their analysis "suggests that differences in early experiences, preferences, opportunities, habits, training and practice are the real determinants of excellence" (p.399). This article generated 30 peer responses, an indication of the level of debate that exists around this topic.

The review of the adult expert literature by Ericsson and Lehmann (1996) pointed to a poor correlation between individual anatomical and physiological characteristics and superior performance by elite athletes, chess masters and musicians, over a wide range of component abilities. This evidence, in conjunction with "strong evidence for adaptive changes through extended practice", led Ericsson and Lehmann to suggest that "the influence of innate domain-specific basic capacities (talent) on expert performance is small, possibly even negligible" (p.281). They contended that individual differences in expert performance are most likely to be predicted by the motivational factors that predispose children and adults to engage in deliberate practice.

Ericsson and Lehmann (1996) concluded that "most types of expertise – even athletic performance – continue to be mediated by cognitive processes such as monitoring, planning, reasoning and anticipating" (p.297). They reported research demonstrating that elite marathon runners continuously monitor their physiological state and the effectiveness of their

running, compared with novice runners who reported deliberately thinking about unrelated matters to minimise their experience of pain.

A number of issues to do with musical experience were explored by Sloboda (1991). He stated that recently published work about musical competence made "little attempt to define or characterize musical expertise" (p.153). According to Sloboda, these studies are a "varied collection of empirical studies on single aspects of what some musicians do", including pitch memory, synchronization in performance and planning a composition (p.153). Sloboda's arguments rest on the notion that declaring someone an expert is a social act that may or may not correspond to an intrinsic characteristic of that person. He explored the notion of musical expertise in the context of its acquisition by members of a culture.

Whilst injury management or prevention did not fall within the scope of his discussion, some interesting questions regarding the concept of musical expertise were raised by Sloboda (1991). He suggested that expertise may not be special in any cognitively interesting sense, asserting that "the majority of our population possess particular types of musical expertise" (p.154). However, he acknowledged that most people referring to musical expertise are talking about overt skills of performance or composition, rather than the musical expertise possessed by untutored members of any culture. He reported two case studies, one a musical prodigy and the other an autistic savant, as examples of people demonstrating overt expertise which had seemingly not resulted from instruction and deliberate practice. However, these subjects are atypical of the general population and of those studying to become musicians. Although these studies may help explore the conditions necessary for the acquisition of expertise, they do not negate one of the conditions necessary for the majority of the general population to achieve expertise in any given domain, that is, the requirement to engage in deliberate practice over many years.

For the purposes of this thesis, professional classical musicians are commonly assumed to possess high-level abilities, if not expert performance, which are recognised by peers and the administrators who employ their services. These levels of ability are demonstrably beyond those of the general population. Although discussion of whether talent is innate or can be

learned are interesting, particularly in terms of the implications for who is selected for further training and assistance, they do not provide any insight into the mechanisms for intervening to prevent or manage injury. However, it is possible that there may be some link between the motivational factors that Ericsson and Lehmann (1996) proposed predispose children and adults to engage in the level of deliberate practice required to become an expert, and the motivation required for the learning and sustained integration into music-making of behaviours and habits which mitigate against PRMD, as proposed by Spaulding (1988).

2.5 Musicians' skill acquisition and playing

2.5.1 Automaticity and skill acquisition

As discussed above, evidence suggests that expert performers, including professional musicians, achieve that level by engaging in extended periods of deliberate practice. The amount of time required to attain high levels of performance has been commented on by a number of authors, including Howe et al (1998), who reported findings of Ericsson et al (1990, 1993) that there are "strong correlations between the level of performance of student violinists in their 20s and the number of hours that they practiced" (Howe et al 1998, p.405). The best students in the performance class of a conservatory had done about 10,000 hours of practice by the age of 21. Those studying to be violin teachers at the same institution had done less than half that amount. According to Howe et al (1998), other studies have shown that regular practice is essential not only for acquiring high levels of ability but also for maintaining it. "Thousands of hours of practicing" are required for competent performance (Paull and Harrison 1997, p.3), and anecdotal evidence suggests that "If I miss one day of practicing, I can tell; if I miss two days, everyone can tell!" (ibid. p.17). Thus current evidence would suggest that few musicians wishing to attain professional performing careers can escape long hours of practice.

Many examples of skill acquisition involve a complex set of behaviours that are individually learned and then incorporated to produce a more-or-less automatic performance. Commonly quoted examples include driving a car and playing tennis. Playing a musical instrument is a highly complex task involving physical and cognitive abilities and critical appreciation. Whether the musician is a professional or an amateur, there is a common set of skills

required to produce music of an acceptable level, that is, acceptable to other professionals and the listeners. However, discussion of the various criteria for determining the quality of music produced is outside the scope of this thesis.

From personal communication with experienced performers and music educators, the complex set of skills required by a professional musician includes:

- the cognitive ability to understand and interpret another language, that is, the set of symbols which constitute a written piece of music, including musical notation and verbal and written directions
- the physical ability to play an instrument, including accurate fine motor skills, playing in tune and on time
- self-awareness/self-evaluation of performance
- the ability to communicate with other performers; for example, following verbal and non-verbal directions during a performance from the section leader or the conductor.

The following section explores a theoretical framework within which competent performance on a musical instrument is viewed as consisting of automatic behaviours as well as conscious or intentional behavioural control.

The different perspectives over time as to whether mental and behavioural processes are consciously or environmentally (automatically) triggered were briefly described by Bargh and Chartrand (1999). They concluded that "the debate has shifted from the existence (or not) of the different causal forces to the circumstances under which one versus the other controls the mind" (p.463). According to Bargh and Chartrand (1999), the cost of exerting conscious, intentional control over every decision and behaviour is not only exhausting, but in fact impossible, considering the barrage of information any person needs to process and act upon during the course of a day. Thus many decisions and consequent actions must be based on non-conscious or automatic processes. The most important attribute of these processes is that they are effortless. Some of these "forms of automatic self-regulation develop out of repeated and consistent experience" (p.476). In this framework, playing a

musical instrument could be considered to have elements of both conscious and non-conscious processes.

Spaulding (1988, p.135) wrote that "the contingency of habit is one obvious aspect of early training that is an underlying theme of the prevention paradigm". The relevance of automaticity theory to this study is the implication that there are two major periods of skill acquisition, that is, initial learning, where playing habits are established and automated, and re-learning certain movements and behaviours following manifestation of a PRMD, where automatic behaviour needs to become conscious (non-automated) and to be revised. If one of the features of skill acquisition is the development of automatic processes, then perhaps among the musicians who have never experienced a PRMD the behaviours responsible for preventing injury are also automatic, and this suggests that there might be difficulty in identifying independent or discrete components of these behaviours. Many clinicians have offered advice regarding behaviours which they believe would prevent or reduce the recurrence of PRMDs, and these are discussed later in this chapter. However, no literature was identified in which there was exploration of professional musicians' beliefs or knowledge about factors mitigating against PRMD.

Although aspects of motor skill acquisition may result in automatic or unconscious behaviours, the use of the conscious mode of executing motor skills results in a much quicker improvement in performance, according to Willingham (1999). In the unconscious mode, only the environmental goal is set, for example, smoothly performing a scale in tune, or changing a bowing pattern to achieve a reduction in shoulder pain during playing. The conscious mode of motor control and motor skills performance includes goal setting, but also entails selecting and sequencing tasks to achieve that goal, such as finger patterns for scales, or changing shoulder and elbow positions and dynamics during bowing. Learning by these two different modes is represented in different anatomical areas of the brain. In functional imaging experiments, a finger-tapping task consciously learned was represented in the prefrontal cortex, as well as supplementary motor and premotor cortices. Little or no activity was apparent in the prefrontal cortex for unconscious learning of this task. The frontal brain activity decreased with practice of the task, starting from when participants reported that they

no longer needed to internally count the finger taps. Frontal brain activity returned when subjects were asked to consciously attend to the task of producing the well learned sequence (Willingham 1999). Thus, practice results in the automatic reproduction of a sequence of movements. As automaticity develops, conscious control becomes unnecessary, until re-learning or modification of the automatic behaviour is needed.

The concept of "choking" in relation to automated behaviours may also have relevance for musicians' performances. *Choking* is a sports colloquialism, referring to failure to perform under pressure. Indeed the performance is often dramatically reduced, with the automatic behaviour which facilitates speed and precision in motor skill reverting to amateur levels with erratic performance. One explanation for this phenomenon is that under conditions of stress the explicit learning system takes over control of motor skills, and the fluidity afforded by automated behaviour is temporarily lost (Gladwell 2000). In a study of the acquisition of a golf-putting skill, Masters (1992) found evidence to support the theory that performers with a small pool of explicit knowledge about how their skill works are less likely to fail under pressure than those with a large pool of explicit knowledge.

Although choking generally refers to failure to perform in front of an audience, the concept may be one that should be considered if a professional musician is attempting to change technique. That is, the imposition of explicit learning on an automated high-level skill might initially result in erratic performance, which could lead to discouragement and possible abandonment of the task if appropriate support is not given to maintain the motivation to change. However, current psychological theory would suggest that, while difficult, there are techniques available for changing habitual, automated behaviours.

As discussed previously, musicians are required to spend thousands of hours practising to achieve a competent performance level. Thus many elements of playing will have become automatic. This suggests that ingrained behaviours which may be contributing to a PRMD need to be identified, that is, made conscious, and changes in technique need to be consciously implemented to effect a change.

Some musicians are reluctant to admit that a problem exists, because that means that it must be dealt with in order to effect a resolution, and for musicians this may involve changing technique and/or playing habits (Horvath 2001, Slade et al 1999), with consequent depletion of the conscious monitoring resources described by Bargh and Chartrand (1999). If playing techniques are observed in advanced students which teachers feel might lead to PRMD, or in professional musicians seeking help because of PRMD related to technique, then these musicians are faced with having to change automated technique.

2.5.2 Changing technique

Although no evidence was identified in the literature regarding musicians changing techniques, one sports-related article discussed changing established movement patterns (Sanders 1995). The ability of nine master swimmers to successfully change from well-established and stable movement patterns for the conventional breaststroke technique to the wave action stroke was demonstrated by Sanders. Statistically significant increases in the amplitude of the fundamental frequency of the vertex of the head, shoulders, hips and knees, as well as changes in the relative phasing of the fundamental frequencies, were identified. These changes were measured after ten 45-minute coaching sessions, with video feedback to participants on days 2 and 8.

It is not known how this information about technique change would translate to changing the skills involved in playing different instruments, as the complexity of the interrelated fine motor skills required to play most musical instruments is far greater than the gross motor movements required for breaststroke. In addition, these changes in technique were not made as a response to injury. Therefore the potential psychological impacts of learning new techniques as a result of injury, and simultaneously continuing one's career, which might impede changing technique, presumably had no bearing on the swimmers' ability to learn the new technique. The use of videotaping to assist with changing techniques for musicians has not been mentioned in the literature, although its use has been described as "essential to diagnose primary and compensatory problems" in musicians by one author (Pacelli 1989).

It is plausible that, consciously or otherwise, some musicians engage in behaviours which mediate the prevention of PRMD. It is proposed that the playing behaviours within a

musician's control, such as taking practice breaks and gradual build-up of performance endurance, are well established over the many years required to reach professional level. The complex motor skills required to play an instrument will be deeply entrenched over the many hours of practice required to reach expert level. No research was identified into musicians' abilities to modify their playing technique. However, the potential for changing even complex motor skills is suggested by Sanders' (1995, p.667) assertion that "the demands placed on the sensorimotor control system (when making a change) may not be large if the fundamental movement pattern remains unchanged". This would seem to imply that small changes to technique in order to reduce the recurrence of a PRMD could be successfully achieved and maintained, whereas a major change in technique might not be achievable at later stages in a musician's career.

The literature points to a belief that the older a musician is, the more difficult it is to break improper practice habits, or to introduce new prevention techniques, and the more susceptible the body is to injury (Hagglund 1996, Spaulding 1988). Rather than being data-based these views may simply be restatements of the commonly held belief that it is impossible to "teach an old dog new tricks". However, Lehrer et al (1993) reported on a 60 year old flautist who experienced a number of playing-related problems which over 2 years resulted in a deterioration in his playing to the point where he was unable to play "the bulk of the orchestral and chamber repertoire" (p.365). Although this flautist was reported to have difficulty in changing his habits, perseverance with exercises designed to release unneeded muscle tension and strict adherence to performing these exercises as part of all warm-ups and during intermissions resulted in a marked improvement in performance over a period of 4 months.

If it is accepted that changing a musician's technique has the potential for reducing the impact of a PRMD and preventing further occurrences, then ways of achieving that change must be explored. The desired changes in technique must be identified. Feedback mechanisms such as video playback must be used to enhance the learning process. An additional factor which would seem to be critical for implementing change successfully is that the individual musician, having been convinced that a change in technique is likely to

produce the desired result of reduced occurrence of PRMD, also needs to maintain the motivational levels to initiate and sustain what may be a prolonged and difficult process because of the complex nature of the activity.

The more difficult the task is to initiate, and/or the more unpleasant it is perceived to be, the less likely the task or project is to succeed to completion (Gollwitzer 1999). Gollwitzer examined the effect of implementation intentions. His recommendations for commencing and sustaining behavioural changes may have relevance for injured musicians. "Good intentions have a bad reputation" because people fail to act on them (p.493). The correlation between intentions and behaviours is modest, and also varies markedly with the type of behaviour, the perceived difficulty of the task, and the perceived degree of unpleasantness of the task.

Implementation intentions specify when, where and how the specified behaviours are to be undertaken, in order to attain the specified goal. Gollwitzer (1999) proposed that when problems are encountered in translating goals into action, such as failing to commence, or failing to persist until the goal is achieved, it is possible to call on automatic processes to help attain those goals. His research suggests that this can be achieved by formulating plans that link anticipated critical situations to goal-directed responses. The control of goal-directed responses is delegated to the situational cues, which when encountered automatically elicit the desired response. Goal specificity results in a better performance than do generally stated goals.

Stating intentions as learning goals rather than performance goals is more likely to result in better performance. That is, the intention is stated as how to learn to perform a given task, rather than how to perform that task. Similarly, there is a better effect when goals are focused on the presence or absence of a positive outcome rather than on a negative outcome (Gollwitzer 1999).

Deciding on how to implement a goal in advance also has the advantage of reducing "effortful deliberations" (Gollwitzer 1999, p.494) at the time of initiating and performing the necessary behaviours. Deciding in advance how to deal with distractions, bad habits or

competing goals can reduce the temptation to respond to these conflicting interests. Goal-directed behaviours that are triggered by situational cues thus become automatic.

Gollwitzer's (1999) research indicates that forming implementation intentions has a strong facilitating effect when action initiation is difficult. Two separate studies reported by Gollwitzer showed that for difficult-to-implement projects, two thirds to three quarters of subjects who had specified implementation intentions completed a given task, compared to one quarter to a third who had not. For tasks that were easy to initiate there was no difference in completion between those who had specified an implementation intention statement and those who had not, with the completion rate being a high 80% in both groups.

In consideration of a musician maintaining a retraining schedule, research on how best to implement and persevere with tasks that are perceived as unpleasant, that is, those that need extra effort because there are immediate costs and only long-term rewards, is very relevant. Gollwitzer (1999) reported on a number of studies that suggested that "strong goal intentions produce drastic changes in behaviour only when they are accompanied by implementation intentions" (p.496). However, it was found that people need to be strongly committed to their goals for the strategy of implementation intentions to work effectively.

2.6 Treatment and prevention

This section details the literature relating to the prevention and treatment of PRMD. Prevention and treatment represent clearly different concepts, but there is often blurring of the distinction in the information identified, as exemplified by Slade et al (1999, p.542), who wrote that "the key to treatment is prevention".

The literature surveyed did not reveal any strategies which musicians who might be regarded as industry survivors had successfully used to prevent injury. One reason for this may be that the successful strategies are in fact not explicit or able to be isolated, in the sense that they may be embedded in a set of complex behaviours developed over many years. It may also be that the successful strategies for prevention that musicians have adopted have not been explored because the recommendations authors have made are based on their clinical experiences with musicians who have presented with injury. Researchers to date have not

studied the injury prevention strategies adopted by asymptomatic musicians who have successfully managed a professional career.

Some of the constraints identified in the literature with regard to musicians' behaviours in risk control and the rehabilitation process include reluctance to report injury, reluctance to rest, difficulty making effective ergonomic changes to instruments, perceived difficulty in acceptance of instrument changes by individual musicians and their peers, resistance to the use of external devices such as supports and straps, and difficulty with gradual re-introduction of activity in the workplace (Norris 1996, Slade et al 1999, Smith 2001, Weiss et al 2001). The range of these factors highlights the fact that it is preferable to prevent injury than to try and manage a complex injury situation.

2.6.1 Prevention

In 1986 Fry asserted that the "prevention of overuse is the control of use" (Fry 1986c, p.731). Joyce Rathbone (1986), writing in response to Fry, expressed concern that emphasis was being placed on ascribing symptoms to "overuse", and concern at the implication engendered of treatment by rest. She commented that as a musician and teacher of considerable experience she was convinced that these painful and incapacitating conditions should mostly be attributed to "misuse", and that therefore treatment based on rest would be at least ineffective and at worst positively harmful. Her hypothesis was that affected musicians should change their patterns of use to effect a cure. The debate regarding nomenclature and its relation to causation has been explored earlier in this thesis. Essentially this issue revolves around whether the incapacitating conditions are in some sense an inevitable consequence of a professional music career for some musicians, given circumstances such as increasing workloads (i.e. overuse) (or similar factors over which the musician may have little or no control), or preventable by the individual musician changing technique or other non-optimal playing-related behaviours (i.e. misuse).

As previously indicated, PRMDs reportedly commence early in a musician's life, with research on student musicians indicating a noticeable level of occurrence (Fry 1986a, 1987, Owen 1985, Zaza 1998). A number of authors have expressed the view that good preventive education places primary responsibility on the individual to adapt to the situation, for

example by monitoring and controlling practice habits. (Fry 1984, Hartsell and Tata 1991, Owen 1985, Smith 2001, Spaulding 1988, Weiss et al 2001, Zaza 1994). If injury prevention is to succeed, students must actively engage in the process (Owen 1985, Spaulding 1988). How these behaviours could best be developed and maintained by students and experienced musicians has not been explored by these authors.

Spaulding (1988) described an interdisciplinary prevention programme at a Norwegian conservatory. The initial programme for entry-level students was obligatory, and subsequent courses were elective. The central focus was on engaging students' participation in monitoring their own practice and playing habits. Difficulties were encountered in enlisting the students' motivation, and were addressed by the interdisciplinary instructor. The issue of motivation is multifaceted, and in this programme efforts were made to acknowledge and address it. However, further details about the methods used to achieve motivation were not reported. Also, numbers of subjects, retention of students once courses were not obligatory, time frame of the report, rates of PRMD pre- and post-courses, and the success of the programme were not specified. It is therefore difficult to reach any conclusions about the effectiveness of this prevention programme.

The Juilliard School in New York, an internationally recognized performing arts educational institution for music, dance, drama and voice, over a period of 12 years gradually introduced on-site medical care and injury prevention lectures. Disappointingly, at the end of that time, student attendance at these lectures was reported to be poor, and students and faculty still did not have "an appropriate appreciation of the crucial role of injury prevention" (Weiss et al 2001, p.2). Again, it is difficult to draw conclusions about how this might have been better achieved, or indeed if it can be better achieved, because of the lack of detail about how the education about prevention was designed and delivered.

One of the reported reasons proposed for music students' poor attendance at non-compulsory injury prevention lectures is that students regard this time as an intrusion on their already busy schedules, detracting from their primary focus, which is learning to be a musician (Spaulding 1988, Weiss et al 2001). Weiss et al (2001) also attributed the difficulties in

educating the Julliard faculty members to many factors, including time-constraints of extremely full schedules, and limited use of effective strategies for this information to be communicated to faculty.

As previously stated, the specialized field of performing arts medicine has flourished for around 20 years. However, it appears that injury rates have not significantly reduced, despite the amount of interest in seeking to understand the nature and cause of PRMD, and the amount of reasonably consistent advice offered to musicians. Nonetheless, more recent writers in the field of musicians' playing-related injuries continue to base their advice on earlier, clinically-generated, preventive advice. For example, Nagai and Eng (1992) based their writing on Fry's work in the 1980s. They stated that postural correction, training of postural muscles, advice on the ergonomics of playing instruments and a possible change of instrument would assist in the prevention of overuse syndromes. Similar recommendations were made by Paull and Harrison (1997), a physical therapist and a musician, based on their experience of injury, treatment and rehabilitation for musicians. Taking into consideration available research in sports medicine, occupational medicine and arts medicine, Zaza (1994) discussed the following preventive measures: modification of practice behaviour; awareness of body movement, posture, breathing; instrument adaptations; exercise and anatomy of playing; and management of stress and anxiety. Preventive behaviours evaluated in relation to playing included warm-up, breaks, pacing, variety of content, and cognitive rehearsal. However, Zaza cautioned that the evidence for many of these recommendations frequently made to musicians was at best equivocal, and urged that "those who teach prevention should be aware of any potential harms associated with their recommendations" (Zaza 1994, p.6).

The meaning of the term "warm-up" is not always clear in the literature, as to whether it refers to a musical warm-up or a cardio-vascular warm-up. To musicians, the term is likely to mean a musical warm-up, which involves playing scales and other exercises on the instrument, at varying speeds. Nonetheless, imprecision aside, warm-ups have been recommended by many authors as a preventive behaviour (Harste 1990, Lehrer et al 1993, Lo Buono 2001, Norris 1996, Owen 1985, Pacelli 1989, Paull and Harrison 1997, Spaulding 1988, Zaza and Farewell 1997).

Zaza and Farewell (1997) found that performing a musical warm-up was protective of a first-episode PRMD, but did not predict risk of recurrence. Taking breaks during practice sessions was found to be protective of a recurrent PRMD. These researchers recommended that a musical warm-up and appropriate breaks be incorporated into musicians' practice routines, as their research suggested that these behaviours had a role in preventing PRMD, were not likely to cause harm, and might benefit the cognitive learning process.

One of the issues identified from reading both the research literature and popular teaching print media is the complexity of determining the optimum posture and technique for any instrument, given the relatively inflexible nature of most instruments in terms of size and shape, and the variation in human anatomy. The lack of agreement by teachers on hand and wrist postures and on optimum sitting posture at the piano was discussed by Rosen (2000). According to this experienced pianist, there is no such thing as an ideal pianist's hands. He cited a range of examples of well known pianists who had small and large hands and the difficulties and advantages conferred by different anatomies. It would seem that attempting to reduce PRMD by matching instruments with anatomies may not be a successful strategy, if there is no agreement amongst professional, experienced musicians about the best match between an instrument and particular physical attributes or body proportions, or optimum posture and technique for any given instrument. Alternatively, more basic descriptive studies may be needed to provide a basis for recommendations.

The advice offered by the above authors suggests that the role of self-management in the prevention and rehabilitation of PRMD can take a number of forms, including disciplined rest breaks during practice and different forms of exercise to maintain strength and flexibility.

The Feldenkrais Method and the Alexander Technique are two systematic approaches which promote movement awareness via selected exercises, and they could arguably be described as fitting in to both treatment and prevention categories. These regimes have been

recommended for musicians by a number of authors (Drake 1993, Fry 1986c, Lehrer et al 1993, Shafarman 1997).

According to Drake (1993), the Alexander Technique has become most widely established in the fields of drama, music and dance. Although the glossary of Paul and Harrison (1997) baldly describes the Alexander Technique as "a school of exercises, posture and movement", and the Feldenkrais Method as "a school of exercise and movement", writers about these methods discuss them in terms of self-discovery, increased awareness and ongoing self-education. The Alexander Technique has been described as a method of self-discovery and re-education (Drake 1993, p.11). It was developed by Frederick Matthias Alexander in the late 1800s. In summary, this technique encourages an exploration of the dynamic relationship between the head, neck and torso, and its impact on function. Via this exploration, an awareness of habitual postural and movement patterns is developed. Analysis of these patterns, with the guidance of a teacher in the initial phases at least, leads to the practice of changed patterns of movement, eventually resulting in improved co-ordination.

Similarly, the aim of the Feldenkrais Method, developed by Dr Moshe Feldenkrais in the 1940s, is stated to be the maximization of integrated function, eliminating any division between the mind and the body by increasing awareness of movement patterns, leading to learning more comfortably and effectively (Shafarman 1997, pp.1-9). It is claimed that the Feldenkrais Method can be used to relieve pain and improve artistic performance (Shafarman 1997). The importance of awareness during training is emphasised by Shafarman, in that "practice strengthens bad habits and overworks already tight muscles" (p.21). He stated that mindless repetition, as in practising scales, reduces awareness.

The anecdotal evidence presented by Shafarman (1997) in terms of maximising function by moving with the least effort, is supported by the review of scientific evidence presented by O'Dwyer and Neilson (2000). The previously discussed assertion that there are advantages to be gained by those who are most economical in their movements, for example being able to do more of the same activity in the available time, or to complete the same task with metabolic energy to spare (Sparrow and Newell, 1998), can be interpreted as being highly

relevant to musicians, particularly if there is a link between volume of work, repetition of movement with elevated muscle tension, and the propensity to develop PRMD.

The concept of movement economy was discussed by Mustonen (2003), an internationally performing concert pianist. He emphasised that each person is different, and all must experiment to find their "own way physically at the keyboard" (Mustonen 2003, p.11). He used the example of playing over a large distance on the keyboard, such as playing over an octave. In his opinion, although keeping the fingers as low as possible to the keyboard might seem to be the most economical way to achieve this movement, it is actually achieved more efficiently by a larger movement of the whole upper limb, allowing it to move in an arc, rather than keeping the hand low to the keyboard and moving it across the distance. By using a larger movement, the original impetus of the movement is assisted to its conclusion by gravity. Mustonen argued that "if you measure it in inches it seems longer, but in energy use it is shorter and quicker" (p.11). However, for playing shorter distances over the keyboard, particularly if speed is required, he recommended keeping the hands low. Mustonen considered himself "lucky" never to have experienced any physical problems, and attributed this possibly to a number of principles he had utilized throughout his playing career, including exploiting gravity and economy of movement, and well-thought out fingering patterns.

The case reports presented by Lehrer et al (1993, p.365) included one in which "exercise designed to decrease or 'release' unnecessary tension in muscles ... led to a marked improvement in the ability to play virtuoso passages and in tone". One of the authors used a variety of methods, including Feldekrais, Alexander and Tai-chi, to develop a set of exercises appropriate to the individual musician's presenting problems. The exercises were designed to release or decrease unnecessary tension and to refine coordinated movements during playing. The validity of each exercise was determined by whether it helped to reduce symptoms and by whether it seemed to "improve facility of playing, accuracy of pitch and quality of tone" (Lehrer et al 1993, p.367). Alexander and Feldenkrais techniques and yoga were also recommended by Fry (1986c) to assist music students gain body awareness.

A gradual increase in practice and playing time and effort in response to an anticipated increase in workload has been recommended by a number of authors (Fry 1984, Nagai and Eng 1992, Palac 1995, Paull and Harrison 1997, Quarrier 1993, Zaza 1994) Workload for a student musician might be increased in preparation for exams, competitions, recitals, or post-holiday (Fry 1986). Similarly, professional musicians might experience an increase in workload post-holiday or in response to a demanding repertoire or performance schedule. The recommendation to increase workload gradually relies on the individual student, the student's teacher, or the experienced musician recognizing a potentially dangerous level of workload, and setting up a strategy to manage the increasing workload. This approach can be viewed as risk management. Risk management is enshrined in NSW Occupational Health and Safety Legislation (NSW Occupational Health and Safety Act 2000, NSW Occupational Health and Safety Regulation 2001, Chapter 2). This process includes risk identification, assessment and elimination or control. Although this legislation places obligations on employers, rather than on the individual or employee, to carry out risk management, the process is a useful framework for musicians to conceptualize the problem-solving steps required to address the issue of increased workload. The process is also detailed in an earlier document, The National Code of Practice for the Prevention of Occupational Overuse Syndrome (1994), which states that it applies to all workplaces. Its scope includes all work processes. This code proposes a three-stage approach to injury reduction. The first stage, risk identification, involves workplace analysis. The second stage is risk assessment of the workplace layout, working postures, duration and frequency of activity. The third stage is risk control, for example, implementing an appropriate schedule for increasing workload. Another example is the modification of instruments or the environment, but there some reluctance amongst the musical fraternity might be encountered, according to a number of authors.

There are differences of opinion about the usefulness of external supports, such as straps, or of instrument modification, in relation to injury prevention. Nagai and Eng (1992) reported that musicians are reluctant to use supports because they cause the instrument to move in an unfamiliar way. Musicians "just don't have time to take the chance that a different bow,

higher chin rests ... will foul us up", and are also concerned about how colleagues and conductors would view instrument modifications (Horvath 2001, p.3).

Even slight changes in instrument set-up may lead to adjustments in playing technique (Horvath 2001). Discussing the level of neuromuscular complexity associated with high-level musicianship, Lockwood (1989, p.222) pointed out that even small errors in the biomechanical systems comprising the arm-hand unit may have "disastrous effects on rhythm and pitch". According to Lockwood, it is the small differences in the accuracy of movements that distinguish expert from ordinary performances, with consequent bearing on career outcome.

Elbaum (1986) considered that the musical instruments and environment are fixed by tradition and are not amenable to modification when occupationally-related problems arise. In his opinion, it is the work-related behaviours, that is, performance and practice habits of the individual musician, that are amenable to modification. However, there are more recent favourable reports about player acceptance of modifications that can improve ergonomics and decrease injuries, such as a strap to reduce static load, orthotic devices to improve grip, key levers lengthened to improve leverage, and gradual acceptance of instrument redesign in some locations (Bejjani et al 1996, Horvath 2001).

Zaza (1994, p.6) cautioned that because "the present understanding of ergonomics and the etiology of playing-related health problems is incomplete", any preventive measure should be carefully assessed by those teaching prevention, to mitigate any potential harms. Marshall and Clare (1987) warned that caution should be exercised when giving prophylactic advice, until the cause of the problem was identified. Nonetheless there has been no shortage of authors offering advice to both student and professional musicians regarding the treatment and prevention of PRMD.

2.6.2 Treatment and rehabilitation

Most authors advocate rest as the cornerstone of treatment in the acute stages of musicians' injuries (Fry 1984, Lo Buono 2001, Lockwood 1989, Slade et al 1999). Writing about students, Fry (1984, p.60) stated that the period of rest "may be months rather than weeks",

requiring great patience of the student, teacher and doctor, to ensure that the programme is adhered to and adequate rest of the injured part achieved.

Fry (1986a) assessed 379 musicians with painful overuse syndrome, including both student and professional musicians. The treatment that evolved from this study was radical rest of the tender structures through total avoidance of pain-inducing activities. Fry's advocacy of rest to control these conditions became widely known.

In response to Fry, Bird (1986, p.916) wrote that, although the experience of musicians' injuries at the music clinic at the General Infirmary in Leeds was broadly similar to that of Fry in Australia, a radical rest programme for more severe overuse syndromes was not appreciated by players in Britain or by orchestra managers, "however attractive this approach might be on theoretical grounds". Bird reported that they preferred to persevere with individual tailoring of a less severe rest programme combined with the use of muscle relaxants or analgesics. He did, however, point out that the large number of patients in the clinic who responded to anti-inflammatory drugs might represent a bias in the selection of patients when such clinics are linked to rheumatology departments.

Respondents to a survey conducted by Fishbein et al (1988) were asked to indicate all the musculoskeletal and other medical problems they had experienced, and which they regarded as severe, with severity defined in terms of the effect on the musician's performance. They were asked which treatments they had tried and which ones they found to be effective. For example, of the 10% of musicians who reported a severe musculoskeletal problem with the left hand, 13% tried physical therapy, and 82% found it to be effective for pain, stiffness and swelling. As "effective" was not defined, the extent to which the symptoms were relieved, including the musicians' ability to return to their normal workload, is not clear. Interestingly, Nagai and Eng (1992, p.28) reported this finding as "Fishbein at al reported that 82% of the sample was successfully managed with physical therapy".

A number of authors have suggested that the skills of physical therapists and musicians could be mutually advantageous in the assessment and treatment of PRMD (Elbaum 1986, Hartsell

and Tata 1991, Keller 2001, Lehrer et al 1993, Lo Buono 2001, Quarrier 1993, Slade et al 1999, Smith 2001, Spaulding 1988). For example, Quarrier (1993) considered that the skills which physical therapists have in "proper training methods" could be an asset in the education of musicians, and that musicians would need to educate physical therapists "about the actual technique and positioning involved in playing an instrument" (p.90). The music instructor and the student would need to evaluate any changes recommended by the physical therapist to "determine if the revised positioning will interfere in skill production" (p.93). A thorough physical assessment of the musician, and preferably also an assessment during playing, are important because the physical findings are likely to be very subtle (Lo Buono 2001).

Taping for sports injuries is a commonly accepted adjunct to physiotherapy treatment for a variety of injuries, including sprained ankles and patello-femoral joint pain. Taping the scapula as a potential method of improving scapula positioning, and thereby possibly modifying neck and shoulder positioning which might contribute to painful structures in violinists, was assessed by Ackermann et al (2002) using electromyographical (EMG) studies. The EMG studies indicated that the short-term application of scapula taping to eight professional violinists did not enhance selected scapula stabilising muscles during playing, nor was the taping well tolerated by the violinists. Ackermann et al. also noted that taping of the left scapula resulted in an increase in left upper trapezius activity, accompanied by a detectable decrement in performance. They concluded that further research would be required before this type of taping could be recommended as an appropriate intervention for professional violinists.

Mental rehearsal, also known as mental imagery, mental practice or visualisation, may have a role in recovery from injury. The technique of mental imagery is often used by sports psychologists working with elite athletes to enhance learning and technique, achieve performance goals, control states of arousal, increase confidence and rehabilitate following injury (Bond 1997). This technique can also be utilised by musicians, "enhancing performance and moderating the length of time spent playing by limiting stressful and

unnecessary repetition and ensuring that practice time is spent effectively" (Paull and Harrison 1997, p.144).

As discussed earlier in this chapter, accurate diagnosis is essential for appropriate and specific treatment. Surgery may be the treatment of choice for some nerve entrapment syndromes if conservative measures fail, or if true carpal tunnel syndrome exists, but surgery is ineffective if pathology does not exist (Lockwood 1989, Mandel 1990). Papsin et al (1996) reported on nine brass players with diagnosable orbicularis oris injuries that were amenable to surgical repair. All successfully resumed playing at their pre-morbid level.

It is necessary for any health professional working with injured musicians to undertake a sophisticated analysis of individual musicians' playing modifications, to avoid exacerbating the problem (Norris 1996, Turner-Stokes and Reid 1998). Norris (1996) provided a number of examples that contrasted the same injury in musicians playing different instruments, and detailed how the return to work would be modified to account for the differences in playing biomechanics. For example, a cellist with right rotator cuff injury should initially avoid the aggravating position of abduction/internal rotation produced by bowing with the tip of the bow, especially on the treble strings. A violinist or violist would begin on the two treble strings, "as reaching for the lower strings with the bow necessitates elevation of the elbow, often above shoulder height, which can aggravate rotator cuff impingement" (p.92).

A gradual return to playing in the post-acute stage has been recommended by a number of authors (Fry 1984, Horvath 2001, Lockwood 1989, Norris 1996, Smith 2001). Fry (1984) considered that the return to playing should be very gradual, under the supervision of the music teacher and advising medical practitioner. Lockwood (1989, p.223) recommended rehabilitation which also included "exercises to stretch and strengthen the muscle-tendon unit".

A gradual increase in students' practice hours was recommended by Fry (1986a). He advocated gradually increasing the number of practice segments, rather than increasing the length of each segment or eliminating rest-breaks, and increasing endurance and confidence

by slowly progressing through increased duration, tempo and complexity of material. Norris (1996) proposed that a return to playing schedule should be detailed, and in writing, to minimize the risks of misinterpretation of the instructions often given by health professionals to return to gradual playing. The schedule should be guided by the severity of the injury. Activities of daily living which might also aggravate the injury need to be addressed, either being avoided for a time or modified so as to be performed in a less painful manner (Fry 1986, Norris 1996).

Although Norris (1996) considered the workplace to be the ideal setting for a graduated and methodical return to work for both functional and psychological reasons, he identified a number of obstacles to this approach for the orchestral musician. In his experience, many musicians made a premature return to work with consequent relapse, particularly if the musician was not under supervision, for whereas they required a physician's authorization to take time off work due to injury they did not usually require such authorization to return to work. Norris also identified possible resistance from other orchestra members who might perceive the injured worker as being afforded an easier playing schedule.

2.6.3 The perceived role of music teachers and educators in injury prevention

There are repeated pleas in the literature for recognition of the magnitude of the problem of overuse injuries and requests for appropriate education at all levels, from student to professional (Fry 1984, 1986b, 1987, Hagglund 1996, Hartsell and Tata 1991, Nagai and Eng 1992, Palac 1985, Spaulding 1988, Weiss et al 2001, Zaza 1994).

The importance of music teachers in the prevention of PRMD was emphasized by a number of authors. Basing their advice on Fry's earlier work, Nagai and Eng (1992, p.29) stated that "music teachers and musicians must also learn how to prevent overuse injuries", and Zaza (1994, p.6) concluded that "teachers are a logical target for education about preventative methods". Fry was of the opinion that the high rate of breakdown seen among the students assessed for his 1984 report "could be drastically reduced if we received a strong sustained positive response from music educators" (Fry 1984, p.63).

Leonard Elbaum, Assistant Professor of Physical Therapy at the School of Health Sciences, Florida International University, commented in 1986 that music teachers generally fail to adapt their teaching techniques to the unique anatomical features of the individual student. The notion that teachers may not sufficiently understand the anatomy and physiology of playing in order to provide sound preventive advice to their students was supported by Barbara Paull, an orthopaedic physiotherapist with 30 years' experience working with musicians. She asserted that "some music teachers, frequently playing in pain themselves, may help to perpetuate the myth that pain is a necessary part of becoming an accomplished musician" (Paull and Harrison 1997, p.8). In her experience teachers had little understanding of the physical effects of repeated exercise or sustained postures.

The belief that the medical and educational systems could be improved to prevent or reduce music-related problems was reported by 68% of the 122 undergraduate students in Hartsell and Tata's (1991) study. The participants suggested that music education should include the teaching of proper stretching, strengthening, relaxation and posture techniques, recognition of injury and management methods, and re-evaluation of technique and playing habits, and that these measures should be introduced early in an individual's music training. Here we see students seeking medical/prevention education, in contrast to the behaviour of the Juilliard students described earlier who tended to avoid such classes. Further research is warranted into the nature of such education and the impact of school culture on valuing and attending such classes.

The critical importance of early music educators in establishing an ongoing awareness of prevention, detection and amelioration, was also emphasised by Spaulding (1988). In his opinion, commonsense, supported by some studies, "points to families and early teachers as the truly appropriate allies of prevention" (p.135).

The belief has also been expressed that an integrated medical and music education/management approach is required if the rehabilitation is to be successful. Spaulding (1988) wrote that "the complexity and multifactorial etiologies of performance related disorders are too great for either the medical or the artistic communities to solve

alone. The development of an interdisciplinary approach is essential in order to provide effective treatment and to successfully reverse the current trend of illness in this treasured occupational group" (p.135). According to Spaulding, "reliable prevention and coping skills are not, in the author's experience, difficult for music students to acquire. The real challenge to the interdisciplinary instructor is in the art of making prevention-consciousness accessible to musicians in meaningful, applied, and supportive ways" (p.135). Brandfonbrener (1988) expressed the opinion that "a physician may be on somewhat shallow ground venturing into the hallowed domains of our major conservatories, but if we are charged to preserve and protect the health of their students and graduates, it is difficult to avoid looking at all the issues".

2.7 Summary

In summary, the literature identifies a high level of occurrence of PRMD or OOS in music environments that may be difficult to physically alter (in aspects such as the size and layout of the orchestra pit). Some elements of individual behaviour may modifiable, such as practice patterns, playing postures and taking appropriate rest breaks. The tools of trade, primarily the instruments, may be difficult to modify, and there are reports of considerable resistance to the use of instrument modifications and external supports. However, it seems that a trend to re-think these "impenetrables" is appearing. The habitual movement patterns adopted during playing are usually well established by the time painful symptoms become problematic and begin to interfere with the musician's ability to continue in the workplace. Hagglund (1996, p.139) wrote, "unfortunately, the older a musician gets, the harder it is to break improper practice habits and the easier it is for the body to break down after even mild misuse".

Determining the most appropriate methods for prevention and management for overuse injuries is a matter of continuing controversy. There are a number of issues, including lack of consistent and accurate diagnoses, and identification of what constitutes best practice, in both prevention and treatment. There is a lack of controlled randomized clinical trials or systematic reviews to support many of the physical treatments favoured for PRMD, for musicians or the general population. Although the absence of RCTs validating the physical treatments and preventive measures used by the spectrum of medical and allied health practitioners working with injured musicians does not necessarily negate the value of many

current approaches, lack of reduction in the occurrence of PRMD over time does raise questions about the consistency of diagnosis and the efficacy of both treatment and preventive advice offered by health professionals and music educators.

The usual rehabilitation approach, including gradual reintroduction of the symptom-producing activity, may be difficult to achieve at work in the music profession. Indeed, the musician must be either fully capable or very close to fully capable in order to be able to return to the workplace.

Taking these points into consideration, prevention of PRMD becomes crucial. The question that arises is whether it is possible to determine the most effective way to prevent PRMD for each individual, and what can be learned about prevention and management from the professional craft knowledge of experienced musicians.

CHAPTER 3

STUDY ONE: INJURY PREVENTION STRATEGIES QUESTIONNAIRE TO MUSICIANS

This chapter presents information on the first of two studies conducted for this thesis. The first study involved the development and administration of a questionnaire to professional musicians exploring their experiences with playing-related musculoskeletal disorders (PRMDs).

3.1 Method

Building on information available in the literature, this study was carried out to obtain more information about professional musicians' advice and opinions regarding effective prevention and management of PRMDs. A descriptive research design was chosen for this purpose and a questionnaire was distributed to employed, classically trained professional musicians. A questionnaire was chosen as the data collection method because it was considered to be a time-efficient manner of obtaining information from a number of musicians. Respondents to the questionnaire were assured of anonymity, with the aim of encouraging musicians to reveal information about their injuries which they might otherwise have withheld because of their perceptions regarding industrially-related sensitivities, such as management's attitude towards the long-term employment of musicians who admit to experiencing injuries that potentially threaten their playing abilities.

Approval to conduct the research was gained from the University of Sydney Ethics Committee. The key issues addressed were confidentiality, the voluntary nature of participation, and the information to be supplied to participants regarding the project, that is, informed consent. (See Appendix I which contains the Information Sheet and the Informed Consent Form for Study Two. Study One participants signified their consent by completing and returning the questionnaires.)

3.2 Participants

The participants for this study were professional, classically trained musicians. The orchestra managers of two professional, full-time, Australian metropolitan orchestras were approached by the researcher, initially in April 1998.

The aims of the study were explained in face-to-face meetings with the managers. Neither orchestra manager permitted the researcher to personally address the musicians to explain the purpose of the study. One orchestra manager requested a copy of the draft questionnaire in order to establish whether the management committee would allow the musicians to participate in the survey. This manager discussed concerns about the confidentiality for individual musicians and the orchestra as a whole, as it was reported that a previous piece of research with this orchestra had been published which was critical of management. This manager was assured that there would be no identification of either the individual musicians or the orchestra. Both orchestra managers stipulated that the orchestras were not to be identified.

The first orchestra had 110 full-time, permanently employed musicians. The second had 70 full-time, permanently employed musicians and also used contract musicians as necessary. Permission was given by the orchestra managers for distribution of the questionnaires.

3.3 The questionnaire

As the literature review had identified considerable information about the types of playing-related injuries reported by musicians, and the anatomical distribution of those injuries, the questionnaire was designed to shift the focus away from primarily gathering information about the nature of musicians' injuries. Rather, the aim was to obtain information on what successful professional musicians' experiences suggested might be helpful strategies to prevent playing-related musculoskeletal disorders occurring, or becoming aggravated. The focus of this study was upper limb disorders.

A number of different questionnaires which had previously been used with to musicians, seeking information about their experiences across a number of different areas including playing-related pain, were accessed via personal contacts. These were reviewed to assist with the questionnaire design. A draft questionnaire was designed, which was then discussed with members of my supervisory panel, and amended in line with their suggestions. In addition, two professional musicians, who were accessed through personal contacts, assisted in

development of the questionnaire, checking the credibility of the questions to the intended audience and the ease of completion. A copy of the final questionnaire form used is in Appendix II.

The questionnaire was divided into six sections, seeking information on:

1. background of the musicians, such as instrument played, average number of hours played per day, and activities during non-playing times. This last item was included to elicit information about whether these musicians regularly engaged in other activities involving upper limb use that might contribute to injury, for example, intensive computer use.
2. work-related pain and dysfunction, including whether regular breaks were taken during practice sessions; reaction to playing-related pain; time off work following work-related pain or injury; and behaviours following a period of absence such as holidays.
3. strategies used to prevent overuse injuries from occurring or becoming aggravated.
4. the sources from which musicians derived information about injury prevention, including any self-directed activities.
5. the advice which musicians believed could be included in training for their particular instrument that might help prevent disruptions to performance or practice later in musicians' careers.
6. the most important advice which an established musician would offer to young musicians starting their careers about preventing or managing overuse injuries.

Different questionnaire items required different forms of response, including tick boxes and circling the most appropriate response on an eight-point scale. Two questions required written responses.

3.4 Data collection

Two methods of distributing the questionnaires were used.

1. Distribution to the orchestra with 110 members: 70 questionnaires were requested by the orchestra manager. The researcher delivered these to the orchestra manager for

distribution to the musicians. Seven completed questionnaires were returned by the orchestra manager, a return rate of 10%. However, it was not possible to ascertain how many musicians had actually picked up the questionnaires as they were not personally distributed to each musician. Thus it was not possible to calculate the real return rate.

2. Distribution to the orchestra which included 70 full-time members and some contract musicians: Only the full-time musicians were approached for this study. As agreed with the orchestra manager, envelopes addressed to individual musicians, containing the questionnaire and a stamped, addressed envelope for return to the researcher, were provided. This method of partially personalising the requests, within the boundaries agreed by the orchestra manager, resulted in a much greater return rate than for the other orchestra. Of the 70 questionnaires delivered in this manner, 21 completed questionnaires were returned, that is, a return rate of 30%.

It was not possible to attempt to increase the return rate from either orchestra by written or verbal reminders to the musicians, as the orchestra managers had stipulated that the researcher was not to make personal contact with the musicians to whom the questionnaires were distributed.

3.5 Results

a) Response rate

Twenty eight questionnaires were completed. The return rate was low, even taking into account reported "questionnaire fatigue" (van Hees 1997) amongst musicians. The data were analysed using SPSS for Windows, Standard Version 6.1.3. As the sample was small it was not possible to draw meaningful statistical inferences by the use of cross-tabulated data. Therefore, the data presented below relate simply to the frequencies of responses to the questionnaire items.

b) Instruments played

The breakdown by instrument is represented in Table 3.1, showing that most of those who responded were string instrumentalists. The majority of respondents, 50%, played the violin

or the viola. This is a higher representation of violin and viola players than identified in other studies; for example, among the 2212 responses received by Fishbein et al (1988), 45% were violin and viola players. In that study, the total population of violin and viola players represented 43% of the total population of 4025 musicians, giving an indication of the expected representation of these instrumentalists in the orchestras surveyed. In Fry's (1986b) assessment of a number of Australian and overseas orchestras, a similar proportion of the 485 musicians assessed, 39%, played these instruments. Fry's report did not include figures regarding the total possible populations. One explanation for the bias towards these two instruments in my study may be that those with experience of PRMDs (most commonly string players) had an interest in responding to this type of research. Eight of the nine violin players and all five of the viola players reported requiring time off work in relation to a PRMD on at least one occasion.

Instrument played	**Number (total = 28)**
Violin	9
Viola	5
Flute	3
Clarinet	2
Trombone	2
Cello	1
Bassoon	1
Oboe	1
Horn	1
Trumpet	1
Percussion	1
Other	1

Table 3.1: Instrument played

c) Characteristics of respondents: age, length of time playing primary instrument, number of hours played per day

The age range was 19 – 51 years, with mean (sd) age of 34.81 (8.10) years. This is similar to the age group studied by Fishbein et al (1988), where the average age (combined genders) was 42 years. It is more difficult to compare the average ages of the musicians studied by Fry

(1986b), as he reported only age ranges. However in Fry's study the largest proportion (20%) was aged 26 – 30 years, with the next largest being 31 – 35 years (17%). The age ranges 26 – 40 represented 51% of the total population, with the age range (19 to more than 70 years) being greater than in my sample.

The number of years of playing their primary instrument ranged from 8 – 39 years (mean (sd) 24 (7.35) years). The number of hours played per day, averaged over the previous three working days, ranged from 2 to 7.33 (mean (sd) 4.8 (1.35)) hours. This figure included practice, rehearsal and all performances. Seventy two percent reported that this was typical of their usual workload.

d) Frequency of instrument-free days

The frequency of musicians' reported instrument-free days is shown in Table 3.2. Only one musician reported always having at least one instrument-free day during a working week. One musician also reported never having days off. Two musicians reported taking 2 days off per week, while 22 reported one instrument-free day.

Frequency of instrument-free days during a working week	**Percentage of musicians who reported (frequency); n=28**
Occasionally	50% (14)
Almost always	25% (7)
Usually	18% (5)
Always	4% (1)
Never	4% (1)

Table 3.2: Reporting of instrument free days during a working week
(Percentages are rounded to nearest whole number)

e) Rest breaks during practice sessions

Table 3.3 shows the rest breaks musicians reported taking during practice sessions. Only one musician reported never taking rest breaks, with the majority (twenty two) taking a break at or before every hour.

Duration of rest breaks during practice sessions	Percentage of musicians (frequency); n=28
Every 30 minutes	36% (10)
Every hour	36% (10)
After more than an hour	18% (5)
About every 15 minutes	7% (2)
not at all	4% (1)

Table 3.3: Duration of rest breaks taken during practice sessions
(Percentages are rounded to nearest whole number)

f) Use of mental practice

The use of mental practice, that is, mentally rehearsing a phrase or passage without physical movement, was identified in the literature as an adjunct to physically practising on an instrument, and was proposed to be a potential way of reducing PRMDs (Paull and Harrison, 1997). Engaging in this practice was reported to varying degrees by all respondents to the questionnaire. Thirteen musicians reported using this technique sometimes, four reported using it all the time, and the other eleven reported using it frequently or most of the time.

g) Participation in other activities involving the upper limbs

Question 8 asked: "Do you participate in activities, other than playing your instrument, which involve prolonged use of, or place a heavy load, on the arms and hands?" Respondents were able to indicate more than one activity. The results are tabulated below.

The majority of these musicians (twelve), reported that they did not engage in any of the nominated activities or other activities that might involve prolonged use or loading of the arms or hands. The most commonly reported activity was using a computer. It is possible that these other activities could have precipitated or aggravated PRMDs. Further research is warranted in this area. Also it would be relevant to explore such compounding effects in the management of individual musicians' PRMDs.

Activity	Percentage of musicians who reported engaging in the activity (frequency)
No other activities in this category	43% (12)
Using a computer	21% (6)
Fishing	14% (4)
House renovation	14% (4)
Other activities	14% (4)
Gardening	11% (3)
Handicrafts	7% (2)
House painting	7% (2)
Painting/drawing	0% (0)
Pottery	0% (0)
Knitting	0% (0)

Table 3.4: Other activities musicians engaged in involving upper limb activity
(Percentages are rounded to nearest whole number)

h) Pain and response to pain

Twenty six of the 28 musicians (93%) reported that they had experienced work-related pain or injury. Of the 28 subjects, eleven reported that they had not needed to take time off work for playing-related disorders. Seven had taken time off work for a PRMD on one occasion and 10 on more than one occasion (ranging from two to more than five occasions).

The period of absence from work for those who had one period of time off work was less than 5 working days for six musicians and 2 – 6 months for two musicians. For those who had required more than one period off work, the period was less than 5 working days for four, 1 – 2 weeks for three, and 1 – 3 months for three.

The majority (20), reported that they responded to playing-related pain either immediately, or if pain persisted for more than one day. Three musicians claimed not to respond to pain at all, that is, neither changing playing habits nor seeking medical help.

i) Perceived relationship between repertoires and pain

As different repertoires place different physical demands on musicians, their experiences relating pain levels to repertoire were sought. The musicians reported the following relation between their repertoire and pain levels:

- 21% (6): a complete relation between repertoire and pain levels
- 36% (10): a large degree
- 21% (6): a moderate degree of relation
- 14% (4): a slight relation
- 7% (2): no relation.

However, the majority of subjects, 89% (25 respondents) reported having little or no control over the choice of repertoire. Therefore this possible avenue for partially reducing a pain-related factor was not available to most of the musicians.

j) Strategies for injury prevention

The literature review in Chapter Two identified injury prevention advice given to musicians which suggested that it was wise to increase playing activities gradually in response to an increased work-load, which could include returning to work after a break away from playing. Question 16 requested information regarding behaviour following a period of absence from playing, for example holidays. The responses are set out in Table 3.5. Respondents were able to nominate more than one response.

As shown in Table 3.5, the majority of these musicians (15), reported gradually increasing practice sessions. This aspect of a career in music-making is completely within the individual musician's control. Three musicians reported gradually increasing performances, and two gradually increasing rehearsals. As the data were insufficient for meaningful statistical inferences to be drawn from cross-tabulation, further information about the circumstances of these musicians who apparently had some degree of control over these two factors could not be established. Twelve of the musicians reported returning immediately to normal levels of activity, that is practice, rehearsals and performances.

Behaviour	Percentage of musicians engaging in this behaviour; (n=28)
Return to usual playing levels of practice, rehearsal and performance immediately	43% (12)
Gradually increase practice sessions	54% (15)
Gradually increase performance	11% (3)
Gradually increase rehearsals	7% (2)
No response	4% (1)

Table 3.5: Response following a period of non-injury related absence from playing
Respondents were able to nominate more than one response
(Percentages are rounded to nearest whole number)

In Section Three of the questionnaire the musicians were asked to indicate, in their view, how useful a number of strategies were in preventing overuse injuries from occurring or becoming aggravated. The responses were scored on an 8-point scale, where 0 indicated that the strategy had not been tried, 1 that the strategy was not useful, through to 7 indicating that the strategy was very useful. These data were recoded to aid interpretation. In the recoded scale 0 indicated that the strategy had not been tried, 1 incorporated responses of 1-3 on the original scale, 2 was equivalent to 4 on the original scale and was designated as a neutral response, and 3 incorporated responses of 5–7 on the original scale.

Table 3.6 presents information relating to modification of practice and performance routines from musicians who had tried a particular strategy, and shows that taking regular breaks and relaxing during playing were the strategies most tried, and most found to be useful.

Modification of Practice/ Performance Routine	Tried: Useful	Tried: Neutral	Tried: Not useful	Not Tried
	% (total number of respondents)			
Regular rest breaks	86% (24)	7% (2)	0% (0)	7% (2)
Active relaxation during playing	75% (22)	11% (3)	0% (0)	11% (3)
Limiting practice time	68% (19)	18% (5)	7% (2)	7% (2)
Changing practice routines	64% (18)	21% (6)	7% (2)	7% (2)
Selection of music	57% (16)	14% (4)	11% (3)	18% (5)
Sitting versus standing for practice	29% (8)	11% (3)	39% (11)	21% (6)

Table 3.6: Responses to modifications of practice/performance routines
Respondents were able to nominate more than one response (The percentages are rounded to nearest whole number. Frequencies are shown in brackets)

The responses to the usefulness of physical supports for the instrument have been summarised under two groupings. These groupings were chosen because the use of shoulder and chin rests is commonly accepted practice amongst violin and viola players, whereas the literature review had identified some mixed responses from other orchestral players regarding the use of physical supports for their instruments. The results regarding the usefulness of chin and shoulder rests are shown in Table 3.7, and in Table 3.8 the responses are shown of the musicians who played instruments other than violin or viola (n=14), regarding the usefulness of other devices to support their instruments. Table 3.7 shows that of the 14 violin and viola players who responded, 11 reported that both chin and shoulder supports were very useful. Two had not tried chin or shoulder rests, and one found these rests to be of neutral benefit.

Physical support	**Tried: Useful**	**Tried: Neutral**	**Tried: Not useful**	**Not tried**
	% (total number of respondents)			
Use of chin rest	79% (11)	7% (1)	0% (0)	14% (2)
Use of shoulder rest	79% (11)	7% (1)	0% (0)	14% (2)

Table 3.7: Violin and viola players' use of chin and shoulder rests
(Percentages are rounded to nearest whole number)

Table 3.8 shows that of the 14 musicians who played instruments other than the violin or viola, eight had not tried using devices such as straps or stands to help support their instrument. Of those who had, four found them useful, although this was not further defined in the data. Of these four musicians, two were clarinet players, one an oboe player and one a bassoon player. That musicians playing these instruments found supports for their instruments to be useful is consistent with the literature (Nagai and Eng 1992).

Physical support	**Tried: Useful**	**Tried: Neutral**	**Tried: Not useful**	**Not tried**
	% (total number of respondents)			
Other supports, eg straps or stands	26% (4)	0% (0)	14% (2)	57% (8)

Table 3.8: Use of supports other than chin or shoulder rests
(All subjects' responses. Percentages are rounded to nearest whole number)

k) Self-management strategies – prevention and management

The responses to the usefulness of the self-management strategies nominated in the questionnaire are represented in Table 3.9. Of these lifestyle strategies, relaxation was considered useful by 23 of the respondents, although this strategy was not further described. Activities such as exercise programmes and walking were found to be useful by 17 respondents each, and swimming by 16. A gym programme was found to be useful by about a quarter, and yoga by about one fifth of the respondents. Approximately one fifth of respondents had tried walking as a self-management strategy for prevention or management of PRMDs, and had not found it to be useful. Three respondents who had each tried swimming, a gym programme and golf reported that they had not found these to be useful strategies.

Self management strategies	Tried: Useful	Tried: Neutral	Tried: Not useful	Not tried
	% (total number of respondents)			
Relaxation	82% (23)	0% (0)	0% (0)	14% (4)
Exercise programme	61% (17)	11% (3)	4% (1)	25% (7)
Walking	61% (17)	4% (1)	22% (6)	14% (4)
Swimming	57% (16)	4% (1)	11% (3)	29% (8)
Meditation	43% (12)	7% (2)	4% (1)	46% (13)
Gym programme	25% (7)	11% (3)	11% (3)	54% (15)
Yoga	22% (6)	7% (2)	7% (2)	64% (18)
Golf	0% (0)	14% (4)	11% (3)	75% (21)

Table 3.9: Responses to different self-management strategies
(Percentages are rounded to nearest whole number)

As Table 3.10 shows, about 40% of musicians in this study reported that "diet" was a useful strategy in preventing overuse injuries from occurring or becoming aggravated. Further information on what the term "diet" meant to the individual musicians could not be determined from the data. Thirty two percent reported that they had tried limiting caffeine intake and found this to be a useful strategy for preventing or managing PRMDs (without stating why this was so). Of the four musicians who had found reducing or stopping smoking to be useful, two played the violin, one the flute and one the clarinet.

Health/lifestyle	Tried Useful	Tried Neutral	Tried Not useful	Not tried
	% (total number of respondents)			
Diet	39% (11)	4% (1)	25% (7)	32% (9)
Limiting caffeine intake	32% (9)	11% (3)	25% (7)	32% (9)
Reducing/stopping smoking	14% (4)	4% (1)	18% (1)	64% (18)

Table 3.10: Responses to changes in a range of health/lifestyle strategies
(Percentages are rounded to nearest whole number)

l) Physical strategies for managing PRMDs

The musicians' responses indicating their experiences with a range of physical treatment modalities are summarised in Table 3.11. These treatment modalities were chosen, based on the literature review which had identified physiotherapy as an effective treatment for some forms of PRMDs (Fishbein et al 1988, Nagai and Eng 1992). Chiropractic and osteopathic treatments were included, as they have elements in common with physiotherapy, such as the use of soft-tissue techniques and joint mobilisations, and are well accepted forms of physical management. Alexander and Feldenkrais techniques were included as the literature review suggested that these are useful forms of treatment and self-management for injuries in musicians and other performing artists (such as dancers). Naturopathy was included to offer an alternative to mainstream therapies.

Sixteen (57%) of respondents had tried physiotherapy and found it to be useful. The problems for which they had received physiotherapy were not further defined. This is a lower percentage than reported by Fishbein et al (1988), who found that 82% of musicians with a severe musculoskeletal problem in the left hand reported physiotherapy to be effective for pain, stiffness and swelling.

Alexander and Feldenkrais techniques were found to be useful by eleven (39%) and three (11%) of the musicians respectively. Chiropractic and osteopathic treatments were each found to be useful by eight (29%) of respondents.

Treatment Modalities	Tried: Useful	Tried: Neutral	Tried: Not useful	Not tried
	% (total number of respondents)			
Physiotherapy	57% (16)	7% (2)	7% (2)	29% (8)
Alexander technique	39% (11)	4% (1)	4% (1)	54% (15)
Chiropractic	29% (8)	11% (3)	11% (3)	50% (14)
Osteopathy	29% (8)	7% (2)	4% (1)	61% (17)
Feldenkrais technique	11% (3)	0% (0)	0% (0)	89% (25)
Naturopathy	11% (3)	7% (2)	11% (3)	71% (20)

Table 3.11: Responses to a range of treatment modalities
(Percentages are rounded to nearest whole number)

m) Medications and the prevention and management of PRMDs

Table 3.12 sets out the responses of the musicians regarding their perceptions of the usefulness of a number of medications. It is debatable whether performance anxiety could be classified as a PRMD in the sense used in this thesis, as the symptoms are short-lived, that is, related to the time spent performing, and thus any musculoskeletal effects such as increased muscle tension are likely to be transient. Nonetheless, performance anxiety can impact on significantly on some musicians' careers. The use of beta blockers to assist with performance anxiety has been identified as a "major question in the field of music medicine" (Fishbein et al 1988, p.4). Fishbein et al found that 27% of their sample of 2212 musicians had used beta-blockers, with the majority of these, 70%, doing so on an occasional basis, without a doctor's prescription. The majority of musicians in my study (18), reported that they had not tried beta blockers. Six musicians reported that they had tried beta blockers and found them not to be useful, with two trying them and finding them useful. This contrasts with the finding of Fishbein et al that 96% of those who occasionally used beta blockers found them useful in reducing performance anxiety.

The item "stress-reducing medication" was included in the questionnaire to cover a range of prescription and non-prescription medications aimed at reducing the symptoms of anxiety. It was reasoned that reducing anxiety might be related to reducing performance anxiety. The majority, 20 (71%), of the musicians reported that they had not tried stress-reducing medication. The eight musicians who had tried this category of medication reported finding it useful. Non-steroidal anti-inflammatory medications are frequently prescribed to assist with overuse syndromes when tendon inflammation may be assessed as one of the sources of the symptoms, but "it is common experience" (Hutson 1997, p.60) that they provide minimal benefit. Nine of the musicians surveyed reported trying anti-inflammatory medication and finding it useful, but the conditions for which they took the medication could not be further clarified from the data. The majority, 27 (96%), of the musicians reported that they had not tried "other medications". One person reported under the category of "other medications" that "microcurrent treatment" was useful.

Medication	Tried Useful	Tried Neutral	Tried Not useful	Not tried
	% (total number of respondents)			
Painkillers	32% (9)	14% (4)	7% (2)	46% (13)
Anti-inflammatory medication	32% (9)	7% (2)	14% (4)	46% (13)
Beta Blockers	7% (2)	7% (2)	22% (6)	64% (18)
Stress reducing medication	29% (8)	0% (0)	0% (0)	71% (20)
Other	0% (0)	0% (0)	4% (1)	96% (27)

Table 3.12 Responses to a range of medications
(Percentages are rounded to nearest whole number)

n) Sources of information during training about PRMD prevention

Question 23 asked the musicians about the sources of information regarding preventing injuries that they had used during their training. Respondents were able to nominate more than one source. The responses were:

- 39% (11) replied that they had learnt about injury prevention from their individual music teachers
- 39% (11) received information from a health professional, for example a physiotherapist or a Feldenkrais practitioner

- 39% (11) reported they had never received any formal information, but had worked out strategies for themselves
- 29% (8) obtained information from fellow musicians;
- 14% (4) had received information from university, as part of coursework, or from a workshop.

Eighteen of the musicians reported that they used the strategies that they found effective for preventing or reducing pain all the time. Nine said they used the strategies only if they had pain or playing was disrupted. One musician did not complete this section.

o) Musicians' opinions regarding information during training to assist in the prevention of PRMDs

Questions 24 and 25 called for written answers. Question 24, "In your opinion, what could be included in the training for the instrument you play which might help prevent disruptions to performance or practice later in one's career?" elicited a variety of responses, which are summarised in Table 3.13.

Two respondents provided no comments, and one replied "don't know". Of the remaining 25 respondents, the most commonly nominated element that was recommended to be included in training to avoid disruptions to performance or practice later in their career was "correct posture", or postural and body awareness.

Element nominated for inclusion in training to help prevent disruptions to performance or practice	No. of respondents (Total number = 25)
Correct posture/posture training/postural awareness/body awareness	15 (60%)
Overall fitness and health/regular exercise/healthy diet/weight control	6 (24%)
Being relaxed, or playing efficiently	5 (20%)
Good teaching from an early age	4 (16%)
Training in stretching	2 (8%)
Regular breaks during practice	2 (8%)
Training in how to manage injuries and prevent recurrence	2 (8%)
Avoiding excessive workload	2 (8%)
Relaxation strategies	2 (8%)
Being made aware of the types of help available	2 (8%)
Appropriate seating	1 (4%)
Personal awareness (that is, body awareness)	1 (4%)

Table 3.13: Summary of responses to Question 24
(Percentages are rounded to the nearest whole number)

In response to Question 25, "What would be the single most important piece of advice you would give to a young musician starting his or her career about the prevention or management of overuse injuries?", two respondents recorded no comments and three others offered comments that were humorous but otherwise not useful in terms of understanding the skills, behaviours and attributes that might contribute to a long playing career:

- *make lots of money and retire early*
- *become a doctor*
- *don't become a fat slob like me!*

The advice offered by the other respondents is summarised in Table 3.14.

Factors nominated regarding the most important advice for a young musician to prevent or manage overuse injuries	**No. of respondents (Total number = 23)**
Physical exercise/stretching and strengthening of muscles	9 (39%)
Regular breaks	7 (30%)
Relaxation of muscles not required during playing	7 (30%)
Good technique	5 (22%)
Posture (during playing)	4 (18%)
Don't play through pain	4 (22%)
Gradual build up of stamina (as a student/following an absence from playing)	3 (13%)
Intelligent practice	2 (9%)

Table 3.14: Summary of responses to Question 25
(Percentages are rounded to the nearest whole number)

The three "humorous" responses noted above were excluded from this analysis, leaving a total of 23 responses. Although respondents were asked to nominate the most important piece of advice they would give to new musicians, 11 provided one answer (as requested), whereas 12 gave several answers. Their combined responses are:

- analyzing and working on technique, playing with good technique
- being prepared to make changes to technique.
- playing with good posture
- intelligent practice (that is, engaging with the requirements of the piece such as attention to difficult passages, and taking appropriate breaks)
- being aware of the body while playing

- relaxation of the muscles not needed during playing, that is, active relaxation during playing
- frequent rest breaks
- pacing one's workload
- stretching and warm-up prior to playing
- a clear focus on what and how one plays
- not playing through pain, responding immediately if pain is experienced during playing, including seeking advice if pain is experienced.

3.6 Discussion

This study explored the experience of musicians employed in two Australian metropolitan orchestras in relation to work-related pain, time taken time off work because of PRMDs, strategies used to prevent PRMDs from occurring or becoming aggravated, and finally the advice they considered to be the most important in prevention of PRMDS, as part of training to be a musician. Although the sample of 28 respondents was small, their reporting of experiencing PRMDs showed a rate of occurrence that was similar to previous research, as further discussed below. These musicians' responses about the strategies they had found useful in preventing PRMDS, and their advice about the information they considered important to provide during a musician's training in order to prevent PRMDs, served as the basis for further exploration in Study Two, as detailed in the following chapter.

The musicians who took part in this survey reported a high occurrence (26 of 28, or 93%) of work-related pain or injury during their careers. Although this figure is higher than that reported in larger scale studies of orchestral musicians (for example, Fry 1986a, Fry 1986b, Fishbein et al 1988, Kivimaki and Jokinen 1994) it is not inconsistent with the findings in those studies that large numbers of musicians experienced PRMDs. It may be that the largely unavoidable low response rate in this study meant that there was an over-representation of respondents who had experienced PRMDs and were more motivated to respond. The low response rate in my study was linked to limited access to the musicians by management representatives in the two orchestras approached, and also to possible "research fatigue" because of the musicians' previous involvement in other research. Comments written on the

questionnaires attested to the weariness musicians have expressed about being asked so often about PRMDs, supporting van Hee's (1997) comments on "questionnaire fatigue" amongst musicians. Thirdly, participants commented on the lack of perceived benefits to themselves (in the form of feedback) from participating in the survey. Due to restricted access to participants I was unable to present the research findings to the orchestra members. One musician, for instance, commented on the questionnaire that the researchers should "actually send results of their research out to some of the participating groups – it might, in the long run, mean more people will reply, since they can see the outcome". Another possible reason for musicians not participating in the survey was suggested by the additional comment that the research would not be beneficial to musicians "if they are being *ruled* by bad management". This comment implies that musicians might perceive scant reason to participate in research if, no matter what the outcome, the results were unlikely to have any effect because of orchestral management strategies or style.

Although the percentage of musicians in this sample who reported having experienced work-related pain or injury during their careers was higher than in other larger scale studies, the impact of PRMDs on their playing career is a relevant factor to consider. An indication of the severity of PRMD may perhaps be inferred from the amount of time taken off work as a result of a PRMD. In this group of musicians, 11 (36%) had taken time off on more than one occasion. This finding is close to that in Zaza's (1998) systematic review, which indicated a PRMD prevalence of 39–47% among adults, after all mild and transient symptoms were excluded from the studies, and to Fry's (1986a) finding that the gross incidence of 64% of his subjects reporting painful overuse syndromes was reduced to 42% once the figures were adjusted to exclude Grade 1 (transient) symptoms. This suggests that although the sample of musicians surveyed in my study was small, their experience of PRMDs was similar to that found in other larger studies.

The questionnaire responses indicated that the professional musicians who participated had clear ideas about the factors they believe to be associated with the occurrence and prevention of PRMDs. The majority, 15 (60%), nominated correct posture, and postural or body awareness as being important. The concept of "good posture" is, however, nebulous. This

important element was not further defined by any respondent. The majority of the musicians had tried the various self-management strategies nominated, with the exception of meditation, which had not been tried by 13 musicians (46%), a gym programme (15 respondents), yoga (18) and golf (21). The majority of musicians who reported using relaxation, an exercise programme, walking or swimming had found them to be useful in preventing or managing PRMDs. These respondents were also all able to identify factors that they believed should be included in the training of musicians playing the same instrument as them, in order to prevent the onset of PRMDs later in one's career.

Question 25 asked for the single most important advice professional musicians would give to a musician starting a career, in order to ensure career longevity. The majority of respondents nominated more than one factor, indicating that these musicians viewed successful self-management for the prevention of PRMDs as multi-factorial. Their advice included stretching exercises and strengthening of muscles, gradually building up the endurance to play for longer periods of time, taking regular breaks during practice, relaxation of the muscles not required during playing, good techniques, good posture during playing, not continuing to play when experiencing playing-related pain, and "intelligent practice". This multi-factorial range of advice is consistent with the forms of advice offered by health professionals, based on their clinical experience with musicians and other occupational groups who experience similar injuries (eg Fry 1984, Harste 1990, Hartsell and Tata 1991, Lehrer et al 1993, Lo Buono 2001, Ngai and Eng 1992, Norris 1996, Owen 1985, Paull and Harrison 1997, Smith 2001, Spaulding 1988, Weiss et al 2001, Zaza 1994). Good technique was nominated by five (22%) musicians. Relaxation of muscles not required during playing was nominated by seven (30%). This activity could be regarded as an element of "good technique". These two responses taken together would comprise the largest group of advice.

Although "correct posture" and/or "body awareness" was nominated by 15 (60%) of the musicians as an element which should be included in the training for their instrument to prevent PRMDs, only four (18%) selected it as an important factor which they would give as part of their advice to a young musician starting their career, in order to prevent or manage PRMDs. This may be partly explained by the other responses to Question 25, such as "good

technique", which were not further defined, but which could be conceived of as an over-arching term, incorporating a wide range of elements such as "correct posture" and "body awareness". Many of the terms used in response to Questions 24 and 25 could be viewed as contributing to the overall concept of "good technique". Further information regarding this point could not be extracted from the data, because of the nature of the available responses; that is, respondents were asked to nominate advice but were not asked to explain what they meant by the terms they used. This finding links to the broader literature on practice knowledge (see e.g. Higgs and Titchen, 2001) which recognises that much of the knowledge practitioners use in their practice can be labelled tacit (implicit, wordless), embodied and experiential. As such it is frequently individual knowledge that is highly contextualised and less amenable to generalised, technical or scientific forms of education and training. A major challenge for educators and researchers is to value, analyse and make explicit this knowledge as the basis for educating new musicians in the practice wisdom of musicians who have succeeded in learning how to prevent and manage PRMDs.

The role of the individual music teacher as a source of information about preventing injury during training was highlighted in this survey. This was perceived as much more significant than the reported learning about PRMD prevention at university or as a part of coursework. Other musicians nominated the individual teacher in combination with other sources such as fellow musicians and health professionals. The importance of the role of music teachers roles cannot be underestimated. They are the earliest source of information and instruction, because of the early age at which most musicians begin training, that is, well before they encounter an injury requiring a health professional's input, meet other musicians who would be able to offer an opinion on injury prevention, or attend tertiary education facilities. Again, the value of practice knowledge is evident as is the lack of systematic education concerning PRMDs in formal education. Further investigation is warranted into what is taught in formal and informal training as well as peer learning situations about PRMDs (their nature and impact on musicians' lives and playing careers) and their prevention and management.

Although the limited nature of the possible responses did not allow for poorly defined concepts, such as "good technique" or "good posture", or the role of music educators in

teaching these important elements to be further examined, the results served as the basis for a further study. To further explore the issues raised in the questionnaire responses, a second descriptive study was designed, as detailed in Chapter 4.

CHAPTER 4

STUDY TWO: INTERVIEWS WITH SUCCESSFUL PROFESSIONAL MUSICIANS

To further investigate the nature and frequency of injuries, prevention strategies and successful management of a playing career by instrumental musicians, semistructured interviews were conducted with professional musicians. Given the reported unwillingness of many musicians to respond to questionnaires (van Hees 1997), an approach using extended interviews with fewer participants was adopted. In this approach the aim is to take account of the complexity of the real-world experiences of participants. It was anticipated that this process might afford insight into the self-reported behaviours of successful career musicians, in comparison with behaviours proposed by clinicians as possibly promoting prevention or successful management of PRMDs. Ethical approval for this study was obtained from the University of Sydney Human Ethics Committee.

4.1 The Participants

The participants approached for this study were all classically-trained professional musicians. Professionally employed classical musicians have been studied by other researchers investigating diverse aspects of PRMD, as identified in Chapter Two, and they have reported high levels of occupationally-related injuries. In this context, a professional musician is defined as someone whose primary source of income is generated from playing an instrument or instruments; that is, they play to support themselves financially. As identified in the literature surveyed regarding expert performance (e.g. Ericsson and Lehmann 1996, Howe et al 1998), musicians who attain professional standing have commonly engaged in many years of intensive and consistent practice to reach that status. The majority of the participants for Study Two also taught student musicians on a regular basis, including school-age, undergraduate and postgraduate students. It was reasoned that these musicians/teachers might therefore possess relevant experience and opinions regarding injury prevention and management, and regarding teaching injury prevention strategies to others learning their craft.

Only experienced, successful professional musicians were invited to participate, because it seemed likely that they might be able to identify the strategies which had enabled them to sustain a career in a field with a reportedly high incidence of playing-related injuries.

Thus these professional musicians may be viewed as "survivors", and therefore as having important information relevant to the question of PRMD.

To recruit participants, the author advertised for classical musicians with experience of a full-time, professional career as a musician, and/or music educator. Ten musicians who met these criteria volunteered, and were invited to participate in a one-to-one interview.

4.2 Method

4.2.1 Research paradigm

This research was conducted within the interpretive paradigm, in which the researcher seeks to understand and interpret the lived experiences of the participants. This paradigm recognises that different people can perceive reality differently and that many aspects of their background, experience and knowledge base can influence how they make sense of and construct knowledge from their understanding of reality. It was acknowledged and valued, therefore, that these participants could have many different ways of understanding PRMDs, and making sense of, managing and teaching about them. A strength of this approach was this capacity to explore the richness and variety of participants' practical, experiential knowledge rather than endeavouring to define or measure PRMDs using empirical, scientific method approaches.

4.2.2 Research approach

This descriptive study used interviews to examine professional musicians' accounts of their experiences, attitudes, beliefs and behaviours relating to the causes of and strategies for preventing and coping with playing-related injuries.

4.2.3 Data collection

To obtain verbal responses from professional musicians, a semistructured interview guide was used (Appendix III). The goal of using interviews is "to obtain descriptions of the life world of the interviewee with respect to interpreting the meaning of the described phenomena" (Kvale 1996, p.5). Within the semistructured format, all interviewees were asked the same core set of questions, allowing similar data to be collected for each interviewee, such as instrument(s) played, number of years playing as a professional, and whether they believed that PRMD could be prevented. The format also gave the researcher the flexibility to explore issues raised by the interviewees (Kvale 1996,

Minichiello et al 1999). This deeper and broader exploration was used to provide valuable information about topic areas that had not been anticipated by the researcher, but which, on further exploration, seemed relevant to the research subject.

The questions developed as the basis for the interviews were designed to elicit information which would first establish the credibility of these musicians as successful professionals, then to explore in greater depth the issues raised by the responses to the questionnaire used in Study One. These issues included whether this group of successful, professional musicians believed that PRMDs can be prevented, or managed, in order to maintain a professional career, and if so, in what ways. Information was also sought as to whether these musicians had received information or training about injury prevention during their student years, whether they believed that it was possible to predict which students might potentially develop PRMD, and whether they explicitly taught their own students about injury prevention.

The interviews were conducted at locations chosen by the musicians. In nine cases this was the interviewee's home. The other interview was conducted in a quiet corner of an airport departure lounge. All interviewees signed a consent form.

Self-disclosure was encouraged by an initial discussion of the assured anonymity of the interviews and discussions of the purpose behind the research. A non-judgmental approach was maintained to information divulged and to requesting further information when it appeared that an interviewee was reluctant to discuss certain aspects. If an interviewee maintained a reluctance to further discuss a certain topic, that choice was respected, and other topics explored. This occurred in one case only. All other interviewees were amenable to further questioning and discussion.

The interviews ranged from 40 minutes to approximately 2 hours. The duration depended on the extent of the individual musician's experience of injury and recovery as well as on individual tendencies to brevity or expansiveness in responding. In total, 10 hours of interviews were recorded for later analysis.

4.2.4 Data analysis

The interview transcripts were analysed using an approach based on the seminal work of Patton (1990, p.379-383). This approach was chosen as it has been adapted by a number of authors in the sports psychology field for interviewing groups with similarities to the musicians in Study Two; that is, small groups of elite performers such as 8-10 elite athletes and weight trainers (e.g. Hanton and Jones 1999, Olrich and Ewing 1999, Edwards et al 2002). A similar method of data analysis has also been used in the health field, to interview small groups such as end receivers of health care (Tse and Yeats (2002) studied the vocational outcomes of 67 people who had bipolar affective disorder), and health-care professionals such as nurses (see Titchen and McIntyre (1993)).

This method involved the researcher repeatedly reading the interviews, to become very familiar with the data. The importance of using verbatim transcripts was emphasised by Patton (1990, p.379-380), so initially the verbatim interview transcripts were read through a number of times to gain an overall sense of the information.

The interview transcripts were each analysed to identify demographic characteristics, (such as the number of years for which each musician had played at a professional level) to identify themes relating to the interviewees' experiences with injury prevention education as a student, to identify their beliefs, such as about the causes and prevention of PRMD, and to identify methods and explanations they used in teaching their students about PRMDs.

Patton (1990) recommends commencing content analysis by elucidating key phrases or terms used by the interviewees. Accordingly, first order analysis was performed, which "captures the precise details of what the participant is saying – the actor's own words are used" (Titchen and McIntyre 1993, p.323). Similar words or phrases were manually noted in the transcripts. These units were then compiled in lists, combining the responses from all the interviewees. Second order analysis involved identifying constructs, "words grouped together in clusters to indicate particular ideas" (Minichiello et al 1999, p.252). These second order constructs form "the building blocks of the formalized account or story" (Titchen and McIntyre 1993, p.311). The next step was to identify a smaller number of themes, in the form of more complex and larger messages, interpretations and

understandings, from the entire set of transcripts. This approach, by which themes and categories emerge from the data, is known as inductive analysis (Patton 1990, p.390).

The advantage of this approach is that it offers a process for gaining access to knowledge about how practitioners of a particular craft perceive their world and operate within it. Interviewees are asked to articulate and explicate "the tacit knowledge that lies embedded within and beneath the practitioner's actions, activities and know-how" (Higgs et al 2004, p.91). The practical disadvantage is that data analysis using the above method becomes extremely time-consuming, and the researcher's background knowledge and experience influences the analysis.

Analysis of the data required decisions about how to categorise responses which could be subsumed in a variety of areas. Responses indicated that the musicians used many terms interdependently. For example, posture was viewed as an integral part of technique, as was the ability to release unnecessary muscle tension whilst playing, but these were also discussed as separate entities. Many of the responses indicated interrelationships between factors. Where such overlaps were perceived the factors nominated were assigned to a grouping, taking into consideration their impact on a professional musician's health and playing. As an example, students commonly have control over the length of playing time by timing their practice breaks, and can choose for instance to take half-hourly breaks, whereas for professional musicians the length of performance is externally determined, and they cannot choose to take a break during a performance. Therefore, taking breaks for a student was grouped under the category of early teaching, but references to the length of performance times for the professional was grouped under the category of external environment. Tables 4.1 and 4.2 summarise the categories derived from the terms used by musicians, and the percentage of musicians who used those terms.

4.3 Strategies to Address Quality in This Research

a) Rigour and transparency

The quality of this research was addressed in part by pursuing rigour in the use and description of the research method. For example, the research activities were selected and implemented in a manner that was congruent with the research questions and paradigm, and the research process (e.g. interview schedule) was recorded in field notes to provide transparency of the process and clear reporting of research activities.

b) Credibility

The credibility of the research lies in the direct accessing of experienced musicians' recollections of their experiences of PRMDs, aspects of their training related to the prevention and management of PRMDs, and experiences with strategies for the management of PRMDs.

During interviews I consciously used active listening to reflect to participants my understanding of the their messages so that I could check it, and to give them the opportunity to correct my interpretation. This strategy was used rather than techniques such as participants checking their own transcripts, as I had limited access to participants because of their very busy schedules. However, I was able to review the emerging themes with two participants who act as "key informants", to check the validity of my emerging findings and to further develop my understanding. One key informant's career spanned over four decades at both national and international levels, as well as teaching undergraduate and postgraduate students. The other key informant was relatively new to the profession, with approximately 7 years' professional playing experience and many years' teaching experience with school-age children. It was reasoned that these two musicians might have different perspectives because of the difference in the time they had spent in the profession, and that if their views about the emerging themes which had been identified were comparable, this would support the credibility of the themes.

c) Ethical behaviour

There were three major ethical considerations in this research:

i) Informed consent

All participants were provided with information sheets detailing the research process and requesting their voluntary participation in this project. They were advised that they could withdraw at any time from the project.

ii) Avoidance of coercion to participate

The procedure deliberately avoided any form of coercion of musicians to participate in the study. I was not in a position of power over their careers or employment.

iii) Anonymity and confidentiality

Confidentiality and anonymity were guaranteed. All of the musicians asked not to be identified, for a number of reasons including sensitivity related to contracts, particular employers and venues. Accordingly, no identifiers of any kind accompany the direct quotations reported here.

4.4 Results A: Profiling the Participants

For the ten interviewees, the total years of playing an instrument ranged from 18 to 64. The total years of playing as a professional musician ranged from 5 to 48. Eight of the musicians had 10 or more total years playing as a professional. Thus these musicians could be viewed as experienced performers in their domain (Ericsson and Lehmann 1996). For the whole group, the total professional playing years was 210 years. Nine musicians played stringed instruments and one played a woodwind instrument. Seven musicians routinely taught students in addition to performance commitments. All had played in a variety of orchestral and ensemble groups, as well as giving solo and small group performances. I viewed this wide range of industry experience as an opportunity to explore whether there would be commonalities amongst these musicians' beliefs and approaches to the prevention and management of PRMDs, for themselves and for their students. The bias towards stringed instrument players in such a small sample was noted and was not regarded as a particular concern, since the literature review had revealed that this instrument group reported the highest levels of PRMD. For example PRMDs were reported by 62% of the string section, followed by 16% of the woodwind section, 15% of the brass, and 7% of "other" musicians in the seminal study of 2122 musicians by Fishbein et al (1988). Therefore, the larger number of string players in the sample may in fact have increased the likelihood of capturing the opinions of players who had more experience of PRMD, either directly or indirectly.

The ten musicians interviewed had difficulty in accurately estimating the average number of hours they played per day because of variability in their workload. This was true for all of the musicians. The employed musicians reported often taking on additional freelance performances outside their employed hours. One employed musician estimated playing for 3 hours per day over the year, but this did not include private practice sessions. Four other musicians reported frequently playing for up to 10 hours per day. Thus the physical demands on these musicians were high.

4.5 Results B: Five Themes

Analysis of the data identified five themes pertaining to PRMDs:

- PRMDs are frequently preventable
- Good early training is a key way of preventing PRMDs
- Player wisdom is important in preventing and managing PRMDs
- Contextual factors often contribute to PRMDs
- Management and re-training can alleviate PRMDs

4.5.1 PRMDs are frequently preventable

Analysis of the transcripts indicated that all of the musicians interviewed held the opinion that PRMDs can be prevented or substantially minimized.

Although only three of the musicians interviewed for Study Two claimed to have never experienced a PRMD, all ten believed that PRMDs could be either substantially minimised or totally prevented. Seven of the musicians believed that PRMDs were avoidable or could be totally prevented. Another held the opinion that this would be possible so long as work demands were reasonable. However, another musician, who played the viola, expressed the opinion that it might never be possible to completely prevent PRMD, "because the nature of the instrument is so unergonomic" [M2][1], but that PRMDs could be substantially minimised by awareness of and appropriate response to excessive physical tension during playing. The remaining musician said was sure it must be possible, but considered that one would be exceptionally lucky to have a career entirely free of pain, as "a lot of people I know do tend to get niggling problems"[M10].

One musician, who had experienced a number of different injuries (both playing and non-playing related) expressed the strong view that:

- *I think anything can be prevented. It is a matter of choice.* [M9]

This viewpoint was supported by another:

- *If we took great care of ourselves we could prevent a lot of injuries.* [M4]

[1] Participant's inputs are labeled [M1]-[M10] to preserve the anonymity of the musicians

4.5.2 Good early training is a key way of preventing PRMDs

The participants' discussions of the influence of early teaching indicated that the professional craft passed on by teachers encompassed a wide range of elements, including the importance of good posture and the awareness of excessive muscular tension. Teachers were viewed as a source of both preventive advice and potential injury, for example by passing on poor technique or not providing adequate advice for a student to learn career-sustaining habits.

Four of the musicians expressed the belief that PRMDs could be prevented through "good teaching" or "good training", which was seen as paramount. Although the other six did not explicitly use these terms, the factors they nominated and discussed demonstrated links between the prevention of PRMDs and training to play an instrument to professional level. These factors included the importance of posture and instrument support to minimize abnormal tension or body postures (e.g. the use of chin or shoulder rests), methods for dealing with excessive muscular tension, and body awareness and playing technique. These factors are discussed further as separate themes for clarity of presentation. However, they were frequently mentioned as interrelated aspects that must be integrated when learning to play an instrument. As an example, the concept of "good posture" is embedded in the concept of "good technique". One cannot have good technique without good posture. However, good technique also encompasses other factors, such as the technical ability to play with accuracy, agility and speed.

In common with the other interviewees, the three musicians who claimed never to have experienced a PRMD nominated good teaching as the basis for career longevity (including lack of disruption or early termination by PRMD). They gave the following reasons why they had been able to avoid PRMDs:

- *I think that the primary reason is that I was taught well.* [M3]
- *I think good training ... my teacher actually had problems and when she taught she concentrated a lot on sort of making the technique as effortless as possible and the posture as good as possible so that you would be less likely to encounter those problems yourself.* [M10]
- *I am a relaxed player; I'm a physically relaxed person. I'm a very nervy personality but I am physically un-tense. Well not un-tense, but I am very flexible.* [M1]

They also offered additional reasons that may have allowed them to sustain pain free careers. Their explanations included:

- *I think body shape might have something to do with it ... the power-to-weight ratio ... actually holding the instrument ... it is less of a strain for a man than a woman, all things being equal.* [M3]
- *Luck.* [M3]
- *I think being relatively coordinated and well balanced.* [M3]

Four of the musicians specifically discussed the influence that an individual teacher can have on the way one plays. They used terms such as "a huge, profound influence on the way you play" when discussing this issue. One opinion was:

- *A lot of bad habits can be passed down* [by the teacher], *often to a student's physical detriment and I just don't think that is right and proper.* [M9]

This musician, an experienced teacher, recommended that students and parents "suss out a teacher" [M9], and find one who had not had much of a history of pain or injury, as in this musician's opinion, the more injury-free the teacher, the better the teacher.

The interviewees all discussed the importance of teaching students an awareness of developing a relaxed playing posture, good technique, and early recognition of what constitutes unacceptable pain levels, in order to prevent and manage playing-related injuries. There was, however, a general criticism of the standards of current teaching:

- *I think, even now with all of the injury prevention things that are going on, there are still a heck of a lot of teachers who don't even know* [about prevention] *or who are misguided and don't do the right sort of thing.* [M6]

Three musicians specifically discussed identifying problems with students who had come to them from another teacher. For example:

- *I have had students come along who have* [been students with another teacher] *for four years and are not in good shape and they tend to either struggle with it or give up.* [M5]
- *I have one student ... and somebody started him off rather badly and he has got a lot of tension.* [M8]

One interviewee alluded to "survival of the fittest", saying:

- *You tend to find with students that if they are having a problem with the instrument they tend to give it up so they never actually get to that professional level.* [M5]

Issues were raised of tailoring teaching to the individual student and of the perceived ineffectiveness of formal lectures to students on injury prevention. The importance of tailoring teaching to the individual was discussed by three experienced teachers of both undergraduate and postgraduate students. Their comments indicated that they believed the teacher has a responsibility to individualise teaching. For example:

- *You have to think of another way of expressing it or showing it, or whatever, it is tailor-made for the student. And you have to learn what that is.* [M9]

One musician, an experienced teacher and performer, made the point that students need to be able to think independently in order to engage with self-analysis of playing technique in terms of muscular tension:

- *I don't think you can get a musician or student to think about their posture until you get them to think for themselves in the first place. Because you have to literally be independent in your thinking to go 'is my arm relaxed, am I holding tension in my neck?'.* [M9]

Such remarks suggest that minimizing tension during playing needs to be individually determined, and is likely to be achieved by trial and error rather than by a rule.

Formal lectures in injury prevention were not regarded as the most effective means of education by these same three musicians. Their comments included:

- *Lectures won't really help.* [M7]
- *Not that I would discourage more formal lessons in music institutions but more of the fact that it is an individual thing. Students come to you with their own sets of problems anyway whether it is physical or mental problem.* [M9]

When questioned on the topic, all the musicians interviewed were emphatic in their statements that they had not been taught about injury prevention by the institution they

attended during their studies at either high school or tertiary level. Receiving instruction from a teacher, in individual lessons, on how to prevent injury was regarded by all of the musicians as occurring only by 'the luck of the draw'.

Some participants reported having received sound early instruction, followed by inadequate or detrimental advice later in their studies, which they were able to discount because of the earlier experience. Five of the musicians discussed the teacher's importance in incorporating PRMD-preventive behaviours into lessons. One musician described the importance of clear instructions combined with experiential learning:

- [my individual teacher] *was very clear with words and explanations of why things were, and you need to do that rather than just be shown, because it doesn't stick in the head so much.* [M7]

One musician who was also an experienced teacher expressed the opinion that:

- *I don't think teachers teach you preventative things. It is not like that...the way I see it, a student is like a mould of clay and the teacher moulds that. They will teach you things that in the assumption that everything you do is relatively injury-free and pain-free.* [M9]

One musician explained that looking after oneself is seldom made explicit:

- *No, nobody talks about it. I think* [my individual teacher] *is exceptional in that sense because nobody talks about that. I don't know any string player who has been told how to sit in an orchestra. Posturally, not just 'don't cross your legs', but how to swivel your body or not to swivel your body. I am still doing things wrong all the time.* [M8]

Teaching students how to think about and approach their performance, and encouraging non-playing-related activities such as swimming, stretching or some other form of exercise were considered important by four of the musicians interviewed. This was viewed as an antidote to the intensive and specific muscle use during extended hours of playing. Interestingly, three of the musicians who advocated these measures for their students did not actually take their own advice. The reasons for not engaging in exercise can be myriad, and it possible that these musicians did not take their own advice because they had not experienced any symptoms of sufficient magnitude to interfere with their

playing and non-playing activities, and thus, despite their verbal acknowledgement of the importance of exercise in maintaining a career as a musician, it may not have been viewed as imperative for them at that time.

4.5.3 Player wisdom is important in preventing and managing PRMDs

Players, particularly experienced musicians, commonly developed "player wisdom" or a depth of individual knowing about their craft, including knowledge of themselves (their bodies, habits and approaches as musicians) which was most important in the prevention and management of PRMDs. The term player wisdom can be related to other terms found in the literature of professional practice, such as "professional craft knowledge" (see Higgs et al 2001, Titchen and Ersser 2001) and "practice wisdom" (see Scott 1990).

Professional musicians, particularly those who are "survivors" in this challenging occupation:

- develop body awareness and postural control which can prevent and alleviate PRMDs
- can learn to compensate for a PRMD (a continued playing career is possible in some cases)
- frequently develop their own unique and effective self-management strategies which prevent PRMDs
- learn to use practice sessions effectively and avoid excessive, non-beneficial practice demands
- learn to build endurance and stamina and understand playing effects on the body
- learn to use instrument supports (however, this is not always acceptable; see Contextual Factors),
- learn good playing techniques both for quality playing and for preventing PRMDs
- learn about factors (both playing-related and context-related) that cause PRMDs and learn strategies to avoid, reduce or manage these factors

Body awareness and control

The terms used by all the musicians to discuss the factors that they believed to be important in both the cause and management of PRMDs often focused on bodily or physical factors For example "good" posture and body awareness were viewed as integral

elements in "good" technique. All the interviewees discussed posture as a theme, and six identified body awareness as a distinct theme, as shown in Table 4.1.

Theme	First order analysis: terms used	Number/10 of participants[2]
Body awareness and control (eg posture and tension management) influences PRMD occurrence and severity	- posture - correct posture - sitting posture - shocking postural problems - look bad posture-wise - best posture ... least problems - teaching relaxed posture - natural body posture - physical relationship with their instrument - poor technique includes posture	10
	- subconsciously mimicking teacher's posture	2
Body awareness is vital in PRMDs prevention and management	- body awareness - awareness - management comes through awareness - being aware of your body - physical awareness - listening to your body - body language	6

Table 4.1 Body awareness terms

"Correct" or "good" posture was considered by all the musicians interviewed to be an important part of learning to play an instrument. The terms they used in discussion to describe a desirable posture are summarised in Table 4.1 and include "correct posture", "natural body posture" and "pretty good posture". One musician used the term "body language" and talked about students' "physical relationship with the instrument". One musician expressed the integral role of posture in what is termed "technique", stating that poor technique includes poor posture.

[2] i.e. Number of participants who made this comment or used such terms

Two musicians recounted the experience of realising that they had subconsciously copied their teacher's posture. One considered that the importance of learning a good playing posture, that could contribute to injury prevention and longevity of career, was not made explicit, but was arrived at by good fortune and learned by copying teachers' postures:

- *I had a teacher when I was at school, and you tend to copy their posture. There is another teacher, for example, who I know, who sits dreadfully and it is interesting when you look at* [their] *students, they sit the same way. I can't help, with what I know now, thinking that those students are not going to make it. But fortunately, the two teachers that I had had pretty good posture and pretty good technique and I picked up on that, but that was more by osmosis.* [M5]

This feature of unconsciously learning a teacher's posture and technique was also described by another musician, despite not having consciously copied the teacher:

- *People have said 'oh my god, you do that just like* [the teacher]*'. I think it is unavoidable when you learn from someone.* [M10]

This comment seems to support the hypothesis that in addition to the explicit skills being taught and gradually learned, implicit skills are also being learned (Masters 1992). The explicit learning in this situation includes the conscious effort to acquire the skills necessary to read music and play an instrument. The skills implicitly learned seem to be appropriate posture, and a particular attitude to self-preservation, that is, one which will facilitate a long and pain-free career.

In relation to the interconnected factors of playing technique, posture and the onset and prevention of playing-related injuries, "tension" was the word most frequently used in the interviews, occurring 60 times. The words "relaxed/not relaxed/physically loose/release" occurred 51 times. The terms tension, excessive muscular tension, and the converse, muscular relaxation or release of muscle tension were variously used by eight of the musicians to discuss a number of factors related to PRMDs.

Playing with excessive muscular tension was viewed as a cause of muscular discomfort, or of more serious PRMDs, by eight of the musicians interviewed. One musician who had experienced a PRMD with subsequent recovery stated:

- *playing injuries, to my mind, come about by playing through a period of extreme muscle tension.* [M2]

The nine musicians who were also experienced teachers believed it was possible to predict which students are likely to experience PRMDs, with one stating that it was 98% possible to do so. On further questioning as to what might alert them to this possibility, all responded that they would look for excessive muscular tension in specific body areas, or overall posture in a student. One string player elaborated on this to include tension observed in either hand, neck pressure on the chin rest, or a poor instrument and chin or shoulder rest set-up, resulting in the neck gripping the instrument.

Analysis of any excessive tension, pain or discomfort was considered vital for isolating the source of a PRMD, and then being able to change it, both for students and experienced professionals, by the nine musicians who taught students. The terms they used included observing a student to be "tied up in knots physically", or to have "extreme" or "excessive muscle tension", or to be "tense". Four of the musicians reported giving advice to students, such as relaxing the neck and shoulder muscles during playing, playing with a totally relaxed or natural posture, the need to be aware of muscular tension and to minimise it by "releasing" the muscles. The need for constant vigilance about muscle tension was captured in the following comments:

- *It is possible with the best possible training to slip into bad habits and then you have to be able to isolate things, like you might suddenly have a sore finger and it is generally traced back to your neck or shoulder muscle ... also I know certainly when I am stressed I do hold the instrument differently than when I am relaxed and that causes extra problems.* [M7]

The comments of one musician who had never experienced a PRMD pointed to the need for some degree of muscular tension during playing, and indicated a belief that there is a relationship between gradations of muscular tension and potentially developing a PRMD:

- *I have never understood this RSI thing. If you start to get tight, you stop, shake out the muscles and keep going ... I think one of the problems is the tension. There is no such thing as tension-free playing. You have to have some tension or you will drop the instrument ... like holding the bow on the instrument ...*

you only have to apply a little bit of pressure or tension at the moment of contact, or at a certain moment when you are moving it. [M3]

This musician also discussed playing in terms of producing "circular motion" rather than a "rigid back and forward" motion. This view was also put forward by another musician [M2] who discussed playing as needing to be "fluid and edge free ... everything is in circles".

All the musicians interviewed discussed the need to be aware of physical tension. Other terms used included body awareness, playing with a relaxed style and making the technique as effortless as possible. This level of awareness was seen as important in preventing PRMDs, and was also discussed in terms of releasing tension in order to create the best possible sound:

- *I think that if you are in a natural position, doing everything naturally the sound is better than if there is tension and there is a block somewhere.* [M3]

Another musician used an analogy to describe the effect of playing with excess muscular tension:

- *It is really like expecting a clogged-up hose to work.* [M9]

Two explicitly stated that prevention was in their control,

- *unless you have a particular weakness in that area.* [M8]

Six of the musicians interviewed discussed body awareness, using that term specifically, as well as discussing posture, muscular tension, dealing with the onset of pain and determining why pain is occurring. The terms used are summarised in Table 4.1. A raised awareness of recognising the signs that an injury might develop from certain postures and behaviours was identified as being important for playing without pain and being able to sustain the long hours necessary for a professional career. One musician stated that this awareness had only developed from contact with two physiotherapists who were being attended for treatment.

Learning to develop an awareness of what one is doing with one's body, and the impact of one's teacher on that process, was described in the following terms:

- *listening to your body when it tells you 'hey you are not doing this properly'. Finally, I think I have come to that point where I am really starting to listen and that is only partly because I have really had a very good teacher like X who has made me more aware of what is should be like ... It's when a teacher doesn't tell you what it should feel like when it is right. You don't quite know. You are going on thinking, 'oh this must be right'. Your understanding of things is vaguely this, that and the other and you think you must be playing right. But you know that something is wrong because the hand or the muscles don't feel right ... as I said early, if it feels physically relaxed then fine, the technique will take care of itself because I don't think you can have a proper technique until you are totally relaxed and you are doing something that is totally natural.* [M9]
- *Everybody is different and everyone needs to have different things applied to them and provided you have got a good teacher and good powers of observation and follow your body's needs you can take what you need and that is a mixture of exercise and preventative stuff.* [M7]

Effective practising

Table 4.2 lists the terms used by the musicians to describe practice habits.

Theme	First order analysis: terms used	Number/10 of participants
The role of practice habits in preventing PRMDs	- practice without a break (is detrimental) - poor practice habits - importance of taking breaks - don't wait until you are exhausted	7

Table 4.2 Terms used relating to good practice habits

The number of hours of practice required to reach a professional standard was discussed by two musicians. One reported practising 6–10 hours per day as a student. The other stated that, as students, they were encouraged to practise 4–6 hours per day, and that 4 hours was considered adequate. This musician discussed the issues of quality and quantity of practice, in the following way:

- *I had a very famous teacher, one of the most famous of his generation. He said that if you have to practise more than 4 hours a day, take up another profession.* [M3]
- *Four hours of quality practice is worth 12 hours of bad practice. You would probably just be practising bad habits if you did 12 hours and weren't really thinking. It would just be mindless repetition at that stage.* [M3]

The importance of the quality of practice was supported by another musician who was an experienced teacher as well as a performer, who advocated practice breaks for students, perhaps after an hour. This musician [M6] had observed that "practice starts to become useless and often counter-productive" once "the attention span and the mental thing" are exhausted.

An interesting insight as to why students might engage in more than 4 hours practice was offered:

- *In intensive summer courses for 8 or 9 weeks it became a bit of a matter of honour at certain* [music] *camps that I know, to be the last one standing ... and kids would be doing 12 hours a day practice.* [M3]

Learning to build endurance and stamina; Understanding playing demands

Table 4.3 shows the terms used by participants to describe their strategies and habits for building stamina and prevent PRMDs.

Theme	First order analysis: terms used	Number/10 of participants
Gradually building up playing stamina will assist in the prevention of PRMDs	- building up stamina - build up strength - gradual approach	5

Table 4.3 Terms used relating to building playing stamina

Talent alone was not viewed as a sufficient basis for a successful career, with the proviso that a certain amount of talent was necessary. One musician expressed the opinion "that you can be a good player if you have a lot of talent without much work" [M7], but that the

lack of solid grounding may later lead to problems, from not having gradually built up the necessary muscular endurance, and created the underlying automaticity which would allow difficult passages to be performed without failing. This musician further commented:

- *There are an awful lot of talented beach bums because they haven't got over the hurdle of not wanting to do the work, or it is all too hard or whatever reason.* [M7]

Taking a tough-minded approach to the work needed, career longevity was seen as resting on the basis of:

- *a lot of good bone-crunching work ... somewhere along the line you have to do the hard work.* [M7]

Three of the most experienced musicians mentioned the musculoskeletal adaptations that can occur as a result of early and prolonged training. These included differences in size between the upper limbs, and differences in the shape and flexibility of the fingers on each hand, because of the different functions of each upper limb and hand in playing stringed instruments. One attributed these adaptations to the asymmetrical nature of playing stringed instruments:

- *there must be some sort of imbalance that constantly pulls and tugs and deforms and shapes bones.* [M3]

Starting to learn a musical instrument at an early age was seen as important because "things are malleable" [M3]. One musician put it this way:

- *Your muscles aren't as set, and your ligaments aren't as set. You have the possibility of training them more easily when you are young ... providing you are properly taught of course.* [M6]

Five of the musicians who taught students discussed the importance of gradually building up the physical stamina to play for increasingly longer periods. This is important for professional life as, for example, a single act of an opera may run for an hour, and may involve deep concentration if the piece is complex. One musician explained that professionals can be required to play with full concentration for prolonged periods. This musician gave examples of the Verdi Requiem, where "there is no pause" [M6], and of

playing in a quartet or chamber orchestra where they might typically play for 2 hours before anyone called for a break. Another musician nominated a Wagner opera as an example, where the first act takes "an hour and ten of very concentrated playing" [M7].

Learning to use and value instrument supports

The role of supports, such as chin and shoulder rests and straps, in assisting optimum posture and eliminating unnecessary tension was identified as important by 8 of the interviewees (see Table 4.4).

Theme	First order analysis: terms used	Number/10 of participants
The role of instrument supports in preventing PRMDs	- vital - paramount - go towards preventing a problem developing than to solve an already there problem - very important	8

Table 4.4 Terms used relating to instrumental supports

All of the violin and viola players reported that supports, in their case chin and shoulder rests, were of paramount importance in mitigating against injury. The use of such supports was viewed as normal behaviour:

- *They are very good. We are all built differently, we all have different ways to play. Chin rests, shoulder rests, some do without, but I have to have both, a certain shoulder rest.* [M8]
- *Absolutely paramount ... The instrument should be self-supporting and should sit on the shoulder effortlessly. If it requires downwards pressure from the head then that is asking for injury to happen.* [M2]
- *I don't know if they are going to solve any problem, but they will prevent, I mean they will go further towards preventing a problem developing.* [M1]
- *You have already put an enormous obstacle in front of you if you are not properly set up.* [M6]
- *The set up of how and what you put on your* [instrument] *to help you hold it up, I believe is of vital importance. I found this with students and I have spent*

lessons where we have hardly done anything else but try and get them comfortable. [M6]

- *I have never played without one so I would say they are a positive for the most part.* [M3]
- *That whole sort of supporting the instrument thing. Oh yeah, very important.* [M10]

However, a non-string player was of the opinion that while supports are well accepted among the string players, the other musicians might perceive the use of external supports, such as straps, as "weak, wussy, whatever" [M5]. Another opinion was that:

- *If it was a new support that no-one had seen, I think you would be very wary.* [M4]

These opinions were at variance with the opinions expressed by the string players, who when discussing the types of supports or straps non-string players might use stated:

- *If I see someone like that I think that they have a weakness there, so they are being sensible. I wish I could do it with my* [instrument]*!* [M8]
- *I think musicians, professional musicians, look at all the variations of these things with an understanding eye and think that if that is the best way for that person to play that instrument, then that is absolutely fine by them.* [M1]

The role of playing technique in preventing PRMDs

As shown in Table 4.5, eight of the interviewees discussed the importance of developing "good" technique. Good technique, in relation to the prevention of PRMDs, was mainly described by these successful musicians in terms of being aware of what one was doing while playing, paying attention to any areas of unnecessary tension, and dealing with those when they became apparent. It was also discussed in terms of making the technique as easy or as effortless as possible. Additionally, good technique was described as including a proper instrument set-up, so that the body was not straining to support the instrument.

Theme	First order analysis: terms used	Number/10 of participants
The role of playing technique in preventing PRMDs	- poor technique - teaching effortless technique - technique as easy as possible - poor technique includes posture and everything - had to drastically alter my technique - set it up pretty right straight from the beginning - most relaxed technique - how you are playing - the mechanics of playing	8

Table 4.5 Terms used relating to good playing technique

The role of practice habits in preventing PRMDs

Experienced musicians commonly develop practice strategies and habits that assist in preventing PRMDs. The role of practice habits in preventing PRMDs was discussed by seven of the musicians. The importance of taking regular breaks and not waiting until physical and/or mental exhaustion set in was emphasized. Regarding scheduling practice breaks, the advice these musicians gave to their students varied from playing in 10-minute blocks to taking a break every hour to an hour and a half. One musician's opinion was that as a professional, playing for 2 hours without a break is highly likely to be detrimental in physical terms.

Only two musicians raised the topic of physical warm-ups. One who had not experienced a PRMD said that:

- *I like to do at least a warm-up, probably an hour or two every day, on a quiet day.* [M10]

The other, who had experienced PRMDs, discussed the relationship between not warming up and PRMDs:

- *particularly* [in] *an orchestra where for example you are cold for minutes and minutes and half hours on end, and then all of a sudden you have to come in with a big technical thing.* [M9]

Understanding playing-related factors that cause PRMDs and learning strategies to avoid, reduce or manage these factors

As shown in Table 4.6, the most commonly nominated cause of PRMDs for professional musicians was the volume of work. Seven of the musicians discussed the quantity of playing or work, and the resultant fatigue from increased workloads. The next most discussed cause (six interviewees), was poor technique, or "bad usage". Further discussion revealed that many of these proposed causes were seen as interrelated. Fatigue was discussed both as a result of the volume of work, and a cause of technique deteriorating, resulting in the potential occurrence of a PRMD. Player boredom when in orchestras was also suggested by two musicians as potentially leading to poor posture and resultant poor technique, with the potential for playing-related injury.

Three of the interviewees qualified their discussion about whether PRMDs could be prevented for professional musicians by stating that this should be possible, providing that the amount of work was reasonable and could be controlled. These three also identified the relationship between volume of work, recovery time and developing PRMDs. One put it thus:

- *If you don't have that recovery time then that is when you get into strife, and that is certainly what I found.* [M5]

Another musician held the opinion that developing a PRMD:

- *... depends on how much work you do. We recently have done such an enormous amount of hard physical work that you do get stress combined with a lot of work ... you do get very tired.* [M7]

This opinion was held by another musician, who also nominated playing technique as having a role in causing PRMDs:

- *I think it is the quantity of playing first of all and, secondly, the way in which one plays ... one can play with bad physical habits which will lead to physical problems.* [M1]

An increased workload was identified as leading to poor technique:

- *Three hours equates to a normal 8-hour shift for most people. I am about as tired as anyone would get after an 8 hour normal workload and I think that*

when you get tired because of that, if you are doing back to back [performances and rehearsals] *you get more sloppy in your technique. And if you are getting more sloppy, you are using the wrong technique.* [M9]

This implies that technique deteriorates with fatigue.

Theme	First order analysis: terms used	Number/10 of participants
Understanding musicians' behaviours or responses perceived to contribute to PRMDs	- quantity of playing or work, intensive periods of work - fatigue - back-to-back performances (can lead to fatigue and PRMDs)	7
	- poor technique - loss of facility - the way in which one plays - incorrect use - bad usage - bad physical habits	6
	- over-practice	3
	- physical imbalances caused by the unnatural positions needed for playing and supporting the weight of the instrument	3
	- stress of the job leads to muscular tension, and holding the instrument differently - stress can aggravate an injury	3
	- individual variation in response to same workload	1
	- inadequate warm-up for technically difficult passages, and the stress of solos (in an orchestra)	1
	- poor posture	1
	- repetitive actions, tension, and because of the stress of the job you get tension in different areas	1

Table 4.6 Terms relating to understanding of playing-related factors causing PRMDs

Becoming in demand was reported as resulting in an increased workload, with concomitant fatigue and increased stress:

- *If you are a little bit better than the average person you tend to have to work more hours because you are asked to do more things and there is more tension. The fatigue factor also grows because you are much more in the spotlight. People are much more aware of how you play or if you are having a good or bad day. They have higher expectations of what you can do.* [M6]

The impact of mental attitude on musicians' behaviours and the potential for injury was raised by a number of interviewees. One musician, who had never experienced a PRMD, put forward the opinion that being able to sustain long periods of playing, for example a 2½ hour rehearsal:

- *is actually more of a mental alertness issue than a physical issue.* [M3]

The power of the mind to assist a musician to continue to play, despite compensating for an injury, was discussed by another interviewee:

- *Because you want to do whatever it is so much that you will somehow overcome in your mind. Your mind helps you overcome whatever the physical difficulty is.* [M7]

Although seven interviewees cited the quantity of work as a cause of PRMDs, the term "overuse" was not used by any of them to describe this situation. When questioned as to whether an increased quantity of work could result in an overuse injury, responses included:

- *I wouldn't call it overuse, incorrect use yes. Overuse no.* [M9]
- *Bad usage ... That is the simplest way of describing it.* [M6]
- *It is not a question of overuse.* [M3]

The above comments imply that although these musicians identified increased work-load and fatigue resulting from a number of different sources (including high physical work-load) as possible causes of PRMDs, they did not conceptualise these PRMDs as resulting from overuse of their musculoskeletal systems. The link for these musicians seemed to be between high workloads and deteriorating technique, that is, incorrect use rather than

overuse. One musician who had never experienced a PRMD, but who nominated the volume of work as a cause of PRMDs, stated:

- *with proper technique ... I think injury is avoidable.* [M1]

This implies a belief that even if the workload is high, with proper technique PRMDs can be avoided, which is inconsistent with this musician's statement that the volume of work can lead to PRMDs.

Thus it would seem that there is an incongruity between how these musicians conceive increased workload to contribute to PRMDs, that is, by leading to fatigue and poor technique, and how clinicians might conceive that high workloads result in an increased demand on the musculoskeletal system, that is, overuse of the musculoskeletal system, with variable components of static and dynamic loading of the muscles, tendons and other soft tissues. Practice periods can be viewed as part of a musician's workload. Only three musicians nominated over-practice, or intensive periods of practice, as potential causes of PRMD. They did not link "over-practice" with injuries resulting from overuse.

Poor technique, nominated by six of the interviewees as a factor contributing to PRMDs, was further described in terms which encompassed a number of other concepts, such as posture and attitude towards practice. One musician discussed the elements of good technique as including:

- *posture and everything of course, physical things. Again, a lot of mental discipline. I think your attitude could affect you physically and cause injuries.* [M4]

Three musicians also discussed the physical imbalances caused by the very nature of the instruments, resulting in uneven static and dynamic loading on the musculoskeletal system in order to support and play the instrument. Clearly this factor would differ depending on the instrument.

The issue of stress created by hectic schedules and/or demanding performances, its effect on playing and its possible contribution to PRMDs, was specifically raised by three musicians, again with a perceived link between excessive muscular tension and PRMDs, as shown in Table 4.6. One made the point:

- *I know certainly when I am stressed I do hold the instrument differently than when I am relaxed and that causes extra problems.* [M7]

The other musician believed that people did not comprehend the stress generated by public performance:

- *I don't think people have any idea that when you go in how much stress it is to play a perfect encore every single time. People don't seem to appreciate that. They appreciate all the stress a computer person or stockbroker has but I don't think they appreciate the stress that we have every time we go out there and I think that aggravates an injury. Just that type of stress can aggravate an injury, particularly if your injuries are stress-related or provoked by stress.* [M9]

These comments were interpreted simply as a description of the demands experienced by musicians, particularly those playing solos, rather than as a plea for understanding from the concert-going public. This interpretation was based on the matter-of-fact tone of voice used by the musicians and the context of the comments.

However, playing when stressed, or in pain, was not viewed as an ideal way to behave, as the resultant physical problems then had to be addressed:

- *I have never had time off with pain. I have kept going if I have had pain. I shouldn't have.* [M7]

Not all individuals have the same physical tolerance for the same amount of any given activity. One musician commented that with whether or not one sustained a playing-related injury "is such an individual thing physically and mentally" [M4].

Another musician, whose students were predominantly school-age children, developed the argument further:

- *A particular action can occur with each student but it is how it is done by the student that will develop into an injury of some sort. How do you explain the fact that a teacher who teaches x amount of students, why do some of them have injuries and some of them not? ... especially if they happen to play the same piece.* [M9]

This interviewee then nominated poor technique and "over-practice" as causes of injury.

All the interviewees reported playing on through fatigue and pain, and doing this because of the nature of their work, that is, creating performance:

- *You play through the fatigue and if you have an ache or a pain you have to play through that too. The audience paid to come in and they don't want to know if you have a sore neck or sore arm or anything else, so it is a little bit of 'the show must go on' thing.* [M7]

Compensation for PRMDs, permitting a continued playing career

The general consensus as to whether a musician could continue a career whilst compensating for some form of PRMD was that it is possible, depending on the injury and its severity. This view was held by seven of the interviewees, and the terms they used are presented in Table 4.7. One musician said that a full career could be maintained "with a reasonable amount of pain" [M4], and another that "there are ways around an injury that can allow you still to work" [M2]. Another held the view that unless attention was paid to the problem a shortened career could result, "you either compensate for it, or something compensates somewhere" [M9].

Theme	First order analysis: terms used	Number/10 of participants
Compensation for PRMDs, allowing continued career is possible in some cases	- depends on what the injury is, and how severe - develop a different way of thinking - develop a different posture - develop a different way of shifting (fingers on the instrument) - modify repertoire	7

Table 4.7 Terms used relating to compensating for PRMDs

This view was supported by three other musicians who responded by suggesting that one would need to develop a different posture, a different way of playing, and a different way of thinking about one's approach to playing. One of these was in a position to influence repertoire, and suggested that one could adapt the choice of pieces so that less technically demanding pieces were included in performance. However, this was not an option for the

majority of orchestra-employed musicians, as the programmes are not set by the musicians themselves.

Non-playing-related injuries can also impact on a musician's ability to work. For example, a lower back injury could result in pain and reduced sitting tolerance, thereby causing work-related difficulties for a musician employed in an orchestra, particularly if alternatives such as playing in standing were not regarded as acceptable for the orchestra's performance presentation. Seven of the interviewees raised the issue of compensating for non-playing-related injuries and health problems, and effectively dealing with other life events, such as an unpleasant divorce, in order to maintain a career. The consensus was that it is possible to compensate for these factors. In the words of one musician:

- *it is possible to manage your life and manage an injury or a physical difficulty and still do the job.* [M1]

However, two musicians made the point that although they themselves, or people they knew, had successfully compensated for chronic lower back problems which were non-playing-related, they did not believe it would be possible to compensate for chronic PRMDs which directly affected the forearms, hands or fingers, that is, injuries which directly impacted on their ability to play. In other words, a chronic PRMD could be carried for some time if it is not severe enough to preclude playing, but once the severity reaches that stage, it may then be necessary to stop performing for a living. One musician who had experienced a PRMD over a prolonged period, despite extensive intervention, was considering a career change but was finding this decision difficult because music "has been one's identity" [M5] since an early age.

4.5.4 Contextual factors often contribute to PRMDs

External factors, particularly environmental conditions and work-related demands (e.g. schedules) outside the musician's control frequently contribute to PRMD occurrence and persistence, and to the reluctance of musicians to take prompt action to seek treatment of PRMDs or even to acknowledge their occurrence. These factors included the following.

- Workplace and career pressures prompt musicians to delay seeking assistance for PRMDs or to avoid acknowledging them for fear of hindering their employment or careers.
- Workplace culture restricts the use of instrumental support apart from those historically well-established, for example in the string section.
- Workplace culture expects stoicism and not "letting the team down" and frowns on special treatment for PRMD sufferers.
- Job security and preferment is limited if PRMDs are revealed or if consideration is requested when PRMDs occur.

"Hiding" PRMDs and delaying or avoiding treatment

Two musicians discussed denial of persistent pain and the implications of continuing to play despite unresolved pain. The hope expressed was that the pain might go away by itself, and the fear was that:

> - *for you to have to go to a specialist means you might get the worst possible news which is 'you cannot play ever again'. That's why I think a lot of musicians try and fix it up themselves or ignore it because they are too scared to get that horrid truth that might come. Which is what they are doing anyway, they are making themselves go closer to that horrible truth by not actually treating it.* [M9]

One musician with a long-standing career, who claimed never to have experienced any form of playing related injury, commented:

> - *I suppose it would have to be debilitating before they* [musicians] *would seek professional advice ... I think in these days, where player injuries have become a culture of their own in the last 15 years, people have got much more acute sense of the possibilities of where aches and pains can lead to and therefor, possibly do take notice of it and take it seriously at earlier stages.* [M1]

The theme of player injuries having developed a culture of their own was echoed by another musician with a long-standing successful career, who had similarly never experienced a PRMD:

> - *I think that each generation is getting a little bit more wimpish.* [M3]

Two respondents reported that they would avoid seeking assistance from a health professional because they feared that they would be advised to take time off work, something which they were extremely reluctant to do, both for financial reasons and out of fear of losing future career opportunities if they became known in the industry as someone who had had a PRMD. The terms used by the musicians to discuss when they or musicians they knew would seek help for a PRMD are summarised in Table 4.8.

Theme	First order analysis: terms used	Number/10 of participants
Musicians delay seeking assistance for a PRMD for a number of reasons	- has to be pretty bad - have to stop me from performing - would have to be debilitating - wait until they are absolutely dying - quite a while before I did anything - it would have to be fairly noticeable - musicians generally tend to be a bit stoic - bit of a denial thing - put off seeking help because of financial concerns	10

Table 4.8 Terms used relating to delaying treatment

Having to cope with transient pain

Table 4.9 lists terms used by participants to describe how they coped and were expected to cope with transient PRMD pain.

Theme	First order analysis: terms used	Number/10 of participants
Transient pain experienced during training to play an instrument is regarded as acceptable	- go until it starts to feel a bit uncomfortable - you have to go through discomfort - aches and pains that just go with learning the thing - not used to using a certain muscle	8

Table 4.9 Terms used relating to coping with transient pain

The idea that prevention of playing-related injuries might lie partly in the ability to distinguish between acceptable and non-acceptable pain was expressed by a number of interviewees. The necessity of experiencing a certain amount of pain in order to learn to

play an instrument or to learn more complex passages was discussed by eight interviewees. One musician encapsulated the ideas discussed by all of these eight musicians as knowing the difference between transient pain, which was viewed as acceptable, and chronic pain, which was not. This attitude was captured by comments such as:

- *as a professional you should be pain-free but I don't think you can get there until you go through some pain in order to figure out how to become pain-free.* [M9]

and:

- *It is difficult with students because there are aches and pains that just go with learning to play the thing, and certainly if you never pushed through some pain barriers – this is problematic sort of stuff I suppose – but if there are certain barriers that you didn't push through, you would never get to a certain level of playing.* [M1]

Two musicians drew an analogy between athletes and musicians:

- *Like a sportsman, I think you just have to take a certain amount of pain to be the best.* [M8]
- *You just can't be a gymnast and practise for five minutes a day; you can't enter the Olympics.* [M3]

One musician was uncomfortable with the use of the word "injury". This musician described asking students if they felt "uncomfortable" during playing, because "discomfort means a lot more to me than injury. Injured people are in hospital" [M4].

Only one musician [M2] held the opinion that it should be possible "in an ideal world" to achieve a professional level of playing without experiencing any pain, by controlling the amount of playing at any one time during practice sessions, being aware of excessive muscle tension, and taking appropriate rest breaks. However, this musician also discussed the pitfalls of continuing to practise despite awareness of muscle tension, in the pursuit of "cracking the nut". This was described as the belief that one was just about to perfect the execution of a certain passage or phrase, leading one to continue practising "when really your body is crying out to stop the activity".

That some playing-related discomfort is an inevitable part of a musical career was raised by two musicians. One stated that it probably could not be prevented, and the other expressed the opinion that:

- *after a performance at least 75% of the orchestra has got a sore arm or neck to some degree.* [M5]

Expectations of stoicism by the music/orchestra community

Early intervention is viewed as important in the treatment of PRMDs, to prevent the condition becoming chronic with possible reduced function and increased experience of pain. All the musicians interviewed indicated that either they or musicians they knew would be unlikely to seek help immediately for a PRMD. The ten musicians in this study identified a number of different responses to the kind of injuries which would prevent them playing, whether those injuries were playing-related or from other sources. All but one remarked on the stoic attitude of many musicians in relation to continuing with performance, despite pain. Comments included:

- *it would have to actually be stopping me from performing comfortably for me to seek help.* [M4]
- *In my circle it* [PRMD] *has to be pretty bad* [before taking time off]. *They tend to go too far and then realise that it is too late. Then ... some people might be sensible but mostly I think that most people don't realise either ... I have to be tough and sit here and grit my teeth.* [M3]
- *I have my father's ethic ... I never had any sick days. I kept going in ... I sat in peculiar positions ... and I have been trying to sort things out since then but it is, you know, you live and learn. Anyone else who had the same sort of thing I would say take the time off and get yourself treated.* [M7]

The majority of interviewees admitted to having worked despite pain. A common comment was that "the music must go on". One musician asserted that the performance:

- *is everything, it is the ultimate. That is the goal ... . It is not me that is important, it is the performance.* [M4]

However, from the foregoing, it would seem that under these circumstances it is accuracy of awareness of what is tolerable (though hard) and what will be injury-producing that

separates these successful musicians from their peers whose careers have been adversely affected by PRMDs.

Other reasons cited for this type of stoicism included a desire not to "let the side down", not wanting to be perceived as weak by other members of the group or management, and a belief that one is indispensable, expressed by one musician in the following way:

- *I think most people tend to be stoic. If you go off, you are seen as letting your side down and being weak.* [M8]

Although an employed musician might be entitled to sick leave, a reluctance to take it was expressed. Two of the interviewees explained that if they took time off work then another colleague would have to substitute for them, placing a burden on that colleague who would forfeit time off.

One musician identified the combination of the perceived attitude of the other musicians, "they were very supportive for a while … " [M8], coupled with a desire not to let other staff down as creating a strong impetus to return to work and stay there, even though time off for legitimate injury would have been well justified. Two musicians made observations regarding the perceived negative attitudes of other musicians towards musicians who had taken time off work, both for PRMDs and other significant non-playing-related injuries. One commented:

- *If you had some sort of RSI situation you were basically considered weak, but there has been a lot more media coverage and there has been more exposure and people willing to talk about stuff.* [M5]

Another expressed outrage at the attitudes of co-workers towards a musician who was undergoing personal problems significantly impacting on her health:

- *There was a sort of mumbling through the other people* [in the orchestra] *... like, weak person ... why don't they just sort it out. Basically get your act together ... I remember thinking, God!!!* [M8]

Musicians who also took freelance work expressed a fear of not being asked back if they were seen to be unreliable. This issue had aspects of both missed professional opportunities and financial insecurity:

- *You are very worried that no one is going to call you again.* [M9]
- *I think generally musicians, before they have a major injury that would cause them to stop for a substantial amount of time, would put off seeking help and obviously the pressure of having to earn money, especially living as a freelance musician, you don't get paid unless you are working, so that presents a huge problem. If you seek help the therapist says to you 'you must stop playing for 2 weeks' so that is 2 weeks without income which is not viable for many, many people to take that much time off.* [M2]

One reason nominated by three of the interviewees for continuing to perform despite pain or discomfort (including from playing-related and other types of injuries) was either the feeling of being indispensable or the expressed attitude by management or other group members that one was indispensable, resulting in pressure to continue:

- *I never had any sick days. I kept going into work which was ridiculous because I was not indispensable, although in that section I am not so sure ... I was told the next day that I was indispensable and I said I wasn't indispensable at all.* [M7]

The decision to continue playing under these circumstances seemed to be related to the stoicism which the interviewees attributed to musicians, influenced in these participants by an attitude which might be termed "professional pride". This pressure seemed more likely to affect musicians who were in demand. The issue then became one of the quality of music produced if another less talented but "adequate" musician was substituted; that is, professional pride could be seen as one of the elements which kept musicians coming to work when they may have been physically better served by taking some time off.

Some of the musicians reported "staggering" into work, despite being aware that this behaviour was likely to cause or exacerbate playing-related injury:

- *I just had all these gigs on and I couldn't pull out. To me, I couldn't pull out. It was no, I have to keep going and then it* [playing related injury] *finally happened.* [M9]

The fact that individuals have differing responses to pain was brought up by a number of musicians. The perception that some musicians took time off for apparently trivial injuries was captured by comments such as:

- *I think there are two different types of musicians from what I have seen. Ones who have given up so if they have the slightest problem they go off sick. And then you have, and I would have to say the majority ... they are so damned highly professional that they think they can't let this side down and they come in even when they are on death's door or they are in so much pain and they just don't talk about it.* [M8]

Two participants had been treated by the same physiotherapist for PRMDs. They attributed their willingness to seek prompt assistance from a health care professional to their positive experience of effective PRMD management by that physiotherapist. One of them commented:

- *I think if you have had injuries then you are more likely to seek help straight away because I feel that it is sort of going back to being as bad as I was.* [M9]

However the willingness to do so was also seen as influenced by a number of factors:

- *It depends on the upbringing you have had, with your teacher and things like that too.* [M9]

Context-related factors that cause PRMDs

As identified above, the quantity of work was nominated by seven of the musicians as a major contributor to PRMDs. As shown in Table 4.10, five of the musicians identified factors outside their direct control as resulting in high volumes of work, with insufficient recovery time leading to fatigue, having the potential for generating PRMDs. These factors included the sheer volume of work requested by management, and scheduling issues.

Environmental and ergonomic issues were discussed by all ten musicians as potential sources of playing-related injury, and these are summarised in Table 4.10. They included:

- *Bad chairs, bad lighting, bad posture, not enough space so you can't sit comfortably.* [M8]

These factors are obvious sources of unwanted muscular tension.

Theme	First order analysis: terms used	Number/10 of participants
Relationship between work-related demands outside the musician's control and PRMDs	- performance scheduling - back-to-back performances leading to lack of recovery time - fatigue resulting from amount of work we are requested to do - insufficient breaks	5
Role of environmental factors in PRMDs	- importance of sight lines in an orchestral setting - bad chairs [resulting in poor postures] cramped conditions leading to muscular tension - bad lighting [resulting in neck and upper back strain, in order to read music]	6 4 2 1

Table 4.10 Terms used relating to understanding of contextual factors influencing PRMDs

Six of the musicians discussed the importance of sight lines when playing in an orchestra. Sight lines are the angle of the head and body needed to look at the music, the section principal, the conductor and the audience, and depend on where the musician is seated in the orchestra. Poor sight lines were identified as a potential source of PRMDs, because of the compensatory postures which might be adopted. One musician described sitting in positions that were:

- *swivelled and twisted to see the music and the conductor.* [M8]

and another made the link between maintaining such postures and potential injury:

- *in many orchestra settings you have to look at the music and beyond the music you have to look at the conductor and, if you can, have in the same sight line the principal player, that is the ideal situation. But many situations, the physical layout of the music stands and the chairs mean that the sight line is not good, your head has to turn, the instrument might have to go a certain way so you can fit your bow in. Things like that are very definitely highly detrimental to a musician's health.* [M2]

One musician raised the issue of poor eyesight potentially causing problems in the orchestral context, mentioning poor peripheral vision as limiting the ability to observe what the conductor and other musicians in the section were doing. Bad lighting resulting in visual difficulties, sometimes then compensated for by uncomfortable postures, was also raised by one musician as a potential source of PRMDs.

As identified in the literature review, sustaining a relaxed posture for prolonged periods, possibly in the face of difficult physical environments, is considered vital for a musician's career longevity. Four musicians raised the issue of inadequate seating as a primary source of physical discomfort, as shown in Table 4.10. One said that consideration of the individual's height, weight and instrument played was necessary when management was choosing adjustable chairs. Another related having chairs specially made and transporting them to venues when playing in a quartet which toured frequently. One musician's experience was that only the capital city venues in Australia have good chairs, and:

- *You can have really tremendous problems if you have a really long complicated concert where the chairs are uncomfortable.* [M7]

Another described playing while seated on chairs which were:

- *highly inappropriate to sustain a decent playing position.* [M2]

Inadequate physical space was described as likely to lead to playing related injury by two musicians, Table 4.10. They described the result as:

- *that would mean that if a player is too cramped to play in a proper way, it is going to make them tense and cramped and it is certainly going to be a contributing factor in something like that* [playing related injury]. [M1]
- *having to sit not how they would like to sit because of the design of that pit.* [M5]

Industrial hearing loss was also discussed by three of the interviewees. Hearing loss was said to be likely to result for some musicians, depending on their proximity to loud instruments when seated in the orchestra.

Only one of the musicians interviewed independently raised the possible role of industrial matters in relation to PRMDs. This issue was about the volume of work demanded of the musicians, which was viewed as unreasonably high and likely to contribute to PRMDs.

4.5.5 Management and retraining can alleviate PRMDs

The management of PRMDs falls into five broad categories: self-management, training in body awareness, the impact of contextual circumstances beyond the individual musician's control, treatment of PRMDs by health professionals and retraining of playing techniques.

Self-management is largely covered in the earlier section on Player Wisdom, particularly in relation to body awareness and response to tension, and in the section on Contextual Factors, where compensation for environmental restrictions is mentioned. Key sub-themes were:

- Training in body awareness was perceived as an important component of learning to play a musical instrument
- Re-training of playing technique can alleviate PRMDs but this regarded as difficult, particularly in later life
- General fitness or relaxation training was known to be of benefit, taught to students, but often not practised by interviewees themselves

Training in body awareness

These musicians held mixed views about the usefulness of specific training to raise awareness of body positioning and habitual movement patterns, such as Alexander or Feldenkrais techniques. Generally, they expressed the opinion that these techniques are useful, even though the majority (seven) had not tried them. This observation suggests that beliefs about the utility of certain behaviours do not necessarily translate into practice. This in turn raises questions about drawing any conclusions about the usefulness of any particular movement systems based on these musicians' opinions, as they had no direct experience of those systems. Nonetheless they did hold opinions, and as one musician put it:

- *I think any sort of relaxation technique or a better way of holding yourself could be beneficial to every aspect of your playing.* [M4]

It is of note that the three musicians who had undertaken Alexander technique training had also experienced PRMDs. These musicians' opinions were that the Alexander technique had certainly been helpful in their recovery from PRMD and their subsequent self-management. One described it as:

- *extremely useful because it has helped me very much isolate muscle groups and to experience relaxation without the instrument and to find a natural body posture.* [M2]

Another musician who found the Alexander technique useful reported having been very directive with the teacher to ensure that what was taught was completely relevant to the musician's personal needs, and commented that the usefulness of the technique is a very individual thing, dependent on the teacher.

Of those who had experienced PRMDs, but had not explored either technique (that is, Alexander or Feldenkrais), one had no opinion as to the potential effect of these movement integration techniques in preventing or managing PRMDs. One was sure they would be beneficial. Another described the "Alexander technique sort of thing" as being too regimented, an "imposed sort of thing" [M6]. This musician had tried another form of integrated body awareness/movement pattern learning, developed by a practitioner in England and not widely known in Australia, which was described as:

- *A great deal of help ... made me incredibly conscious of what I was doing physically.* [M6]

The opinion that Alexander and Feldenkrais training are too restrictive was also held by another interviewee, who said:

- *Like everything, not one whole thing is correct. I think it is an amalgamation of things.* [M7]

The three musicians who reported that they had never experienced any form of PRMD had no personal experience with either technique. However, one had heard:

- *a lot of musicians talk highly about Alexander technique, more so* [than other body awareness/movement pattern techniques]. [M3]

One was sure that they were very beneficial, saying:

- *I have known people who have used them and it has completely turned them around and it has made huge differences to them.* [M1]

Different ways of raising body awareness were described, including external feedback. External feedback was identified by three musicians as essential for optimising individual posture and technique. This type of feedback can come from being observed by another person, or from the use of mirrors if the musician knows what to look for. Analysis of one's playing technique by an expert, to assist with technique correction, was viewed as crucial by three musicians:

- *You need to be seen by an expert. It can be in a big group, but they have to see what you do with your instrument.* [M7]
- *People can tell you until you are blue in the face to do this and this but unless you are fantastic in your perceptual thing and you are looking at yourself in the mirror then you can't work out what you are doing wrong, somebody has to tell you.* [M7]

The use of mirrors for feedback was described as essential, because "your brain can override all of your senses" [M7], resulting in distorted feedback:

- *Because of this faulty body image thing that most of us have. We think we are doing something and we look in the mirror and we can be doing something quite, quite different.* [M6]

A third musician agreed:

- *A mirror tells you so much, but it doesn't tell you everything.* [M8]

Retraining technique

The potential for retraining technique to mitigate the effects of PRMDs was discussed by five musicians. The terms they used are presented in Table 4.11. All five were of the opinion that it is possible to change technique. The two who had experienced a PRMD at some point in their career expressed the belief that the younger the musician began retraining, the better the results. One who had undertaken changes of technique in the early twenties commented that a particular form of body awareness training with a therapist experienced in working with musicians had assisted:

- *I was still young enough to retrain most of the bad habits.* [M6]

Theme	First order analysis: terms used	Number/10 of participants
Retraining technique is possible, but regarded as difficult, particularly in later life	- it would be difficult to go back - a fairly long and slow and quite painful process - a long and tedious process - diligence to change things - quite difficult to change - still young enough to retrain most of the bad habits	5

Table 4.11 Terms used relating to retraining technique

One of the musicians who had never experienced a PRMD, but had witnessed a friend undertake retraining, highlighted the belief that retraining is a slow process and psychologically painful in terms of frustration, because:

- *You have to go through the process of being a much worse player than you were in order to become a better player ... you have to retrain physical things so you actually lose an enormous amount of proficiency and then have to build it up again from there. It is painful, emotionally painful and frustrating to lose that proficiency.* [M1]

The other musician who had not experienced a PRMD held the opinion that small changes, such as slightly changing the angle at which the instrument is held "won't upset the apple cart". However, this musician also held the opinion regarding retraining that:

- *It is not impossible, but it would be very difficult to go back. I think up to the late teens it would be possible, it would be more difficult in your twenties but not impossible. If something is really a glaring technical problem you have to get on top of it if possible ... diligence* [is necessary] *to change things.* [M3]

This musician compared changing technique to a tennis player learning to change a forehand stroke, and made the interesting comment:

- *I suppose it is possible to learn a different way of hitting it but you might never quite have the same brilliance in doing it.* [M3]

This comment, and that of the musician above regarding the frustration of the process of change, hint at a possible reason for musicians being reluctant to undertake the perceived drudgery and burden of changes in technique, that is, a fear that one will never play as well again if one changes technique. In other words, something which the individual musician considers unique about his or her playing may be lost, and there is no possible way of assessing whether the revised technique will in fact prevent the recurrence of a career threatening PRMD, until after the changes have been thoroughly instituted.

Self-management

The theme that musicians know how to look after themselves to prevent injury, but often do not do those things, was raised by four musicians. The terms they used in discussion are summarised in Table 4.12. It seems likely, therefore, that as with the general population, knowledge and insight do not always translate to action. Comments included:

- *I do think that if we took great care of ourselves we could prevent a lot of injuries.* [M4]
- *It* [participation in preventive exercise] *doesn't take much time and effort and do you think I do it half the time? No!* [M7]
- *I mean I do try and take days off totally from playing. I actually find that I am very bad – I will go months without a day off, literally.* [M9]

Theme	First order analysis: terms used	Number/10 of participants
Physical self-management as a preventive measure by professional musician	- If we took care of ourselves we could prevent a lot of injuries - I wish that I did [go swimming or exercise] - it doesn't take much effort and do you think I do it half the time?	4

Table 4.12 Terms used relating to self management

Summary

The professional musicians interviewed for Study Two were well able to articulate the difficulties inherent in their profession, from a number of perspectives, including playing-related and industrially-related issues. They were readily able to identify factors which they believed to cause PRMDs, and to discuss what they believed did and did not work

for them in terms of prevention and coping strategies in relation to playing-related injuries. In addition to emphasising the crucial role of early teaching in the prevention of PRMDs, these interviewees identified similar factors and issues to those identified by authors in the field.

4.6 Discussion

The ten musicians interviewed for Study Two had been able to sustain professional careers as orchestral musicians for periods ranging between 5 and 48 years, and with eight having more than 10 years of professional playing, despite only three of the interviewees claiming to have never experienced a PRMD. These ten musicians were well able to articulate the difficulties inherent in their profession from a number of perspectives, including playing- and industrially related issues. They were readily able to identify factors which they believed to cause PRMDs, and to discuss what they believed did and did not work for them in terms of prevention and coping strategies for playing-related injuries.

The views of these musicians offer another perspective on the prevention and management of PRMDs, as the majority of the preventive advice offered to musicians is based on the clinical experience of health professionals dealing with an injured population. Only one publication had been found (Zaza 1994) that examined the available research evidence relating to preventive advice given to musicians. The opinions of these musicians were based both on their direct experiences within the profession, as performers and teachers, and on indirect experience via what they had been taught and their knowledge and observation of other musicians. The depth and consistency of these practitioners' deliberations suggest that such accounts could form an important source of information about this topic, from the professional craft knowledge[3] generated by musicians who have successfully sustained careers in a profession which reportedly has high occurrence of PRMDs, and who may be able to offer helpful information and advice to those seeking to join the profession.

[3] Higgs and Titchen (1995) categorised forms of knowledge as propositional (research and theoretical) knowledge, professional craft knowledge (derived from professional experience) and personal knowledge (derived from personal life experience).

All the musicians interviewed expressed the belief that PRMDs can be prevented or substantially minimized. Seven musicians held the opinion that PRMDs were avoidable or could be totally prevented. One musician indicated that this should be possible if workload demands were reasonable. Another, who played the viola, held the view that it may not be possible to totally prevent PRMDs because playing such an instrument "is so unergonomic", that is, the weight of the instrument and the asymmetrical musculoskeletal loading required to play the viola cannot be eliminated. The asymmetrical postures and static musculoskeletal loadings required to play instruments such as violin, viola, cello and double bass have been identified as potential risk factors for PRMD by a number of authors (e.g. Fry 1986b, Hartsell and Tata 1991, Keller 2001, Quarrier 1993, Paull and Harrison 1997, Zaza and Farewell 1997). However, the musicians interviewed for Study Two considered that despite these factors PRMDs could be substantially minimized by awareness of and appropriate response to excessive physical tension during playing.

Another musician expressed the view that it must be possible to have a pain-free career, but that one would be exceptionally lucky to do so, as many musicians have "niggling problems". As all the musicians interviewed for Study Two had sustained professional careers as orchestral musicians, this comment suggests that minor musculoskeletal problems (even if chronic or recurrent) need not impede one's career. This point has implications for researchers in this area, in terms of accurately establishing the extent to which PRMDs impact on a musician's career. Zaza (1998) reported that musicians clearly distinguish between mild symptoms and career-threatening PRMDs, whereas researchers could overestimate the prevalence of PRMDs through the inclusion of such milder symptoms. Therefore the phenomenon under consideration must be clearly defined, so that the research has the potential to be meaningful to the relevant occupational group, in this case, musicians.

All the interviewees were able to identify and discuss risk factors for and ways of preventing PRMDs. Despite this, seven had direct experience of a PRMD, ranging in severity from mild to career-threatening. There are a number of possible explanations for this apparent contradiction. One is that knowledge and insight do not necessarily translate into the types of action that will confer prevention of PRMDs. Another is that the factors, which these musicians believed would prevent the occurrence of PRMDs, may in fact be inaccurate. That is, there may be some other factors which they did not recognise or

identify. While seven of the musicians identified high work-loads (volume of work), and three identified excessive practice as likely to place them at risk of developing a PRMD, they did not support the concept that overuse of the musculoskeletal system could be the cause of a PRMD. Quantity of work and intensive periods of work have been frequently nominated as causes of PRMDs (Fry 1984, 1986a, 1986b, 1986c, 1987, Hagglund 1996, Horvath 2001, Lockwood 1989, Mandel 1990, Marshall and Clare 1987, Owen 1985, Weiss et al 2001).

The musicians interviewed identified high workloads as one of the causes of PRMDs. Some aspects of workload are within in a musician's control, such as the frequency and duration of personal practice sessions, and whether they accept additional performance work outside of their employment. However, as orchestrally employed musicians do not control concert programming, much of their workload is outside their control. Therefore the belief expressed by three of the musicians that prevention of PRMDs was in their control seemed to deny the possibility that beyond a certain workload any musician might succumb to a PRMD. Despite their belief in their own self-efficacy, all three had experienced PRMDs of varying severity. For instance, control over workload might be a "within playing" phenomenon (e.g. control over or self-management of body posture and relaxation within the performance) rather than a more black and white idea of control of whether they play or not and how much.

Two of the musicians interviewed raised the point that not all individuals have the same physical tolerance for a given activity. This possibility was also suggested by Fry (1984) and Lehrer et al (1993), that is, that there is potentially some level of work at which all musicians will succumb to PRMD, but, because of individual variations in physique and in the other factors involved in playing music that will impact on the way the whole person responds to stressors, this point can not be predicted. By contrast, nine of the ten musicians interviewed believed that it would be possible to predict which of their students are likely to experience PRMDs at a later date. (The other musician interviewed did not teach.) These musicians indicated that they believed they would be alerted to the possibility that students might be at risk of experiencing a PRMD if they exhibited excessive muscular tension in specific body areas or overall poor posture. These two elements are discussed further subsequently.

A number of possible reasons were suggested to explain why musicians might continue to endure high workloads, sometimes to their detriment. These included a belief that they were indispensable, or a high work ethic, which entailed an awareness that if they took time off work one of their colleagues would have to replace them, forfeiting their own rostered time off. Nine of the musicians commented on the stoic attitude of many musicians in relation to continuing with performance despite pain. This stoic attitude amongst musicians was also noted by Lockwood (1989) and Owen (1985).

Eight of the musicians interviewed discussed the necessity of experiencing a certain amount of pain in order to learn to play an instrument or to learn to play more complex passages of music. Transient pain during these periods was viewed as acceptable, but chronic pain was not. This differentiation suggests that it is important in the prevention of PRMD to teach students and professional musicians to recognise when pain has moved beyond an acceptable level and duration. Further, they need to learn strategies (e.g. release of muscle tension) that can interrupt the progression of factors (e.g. sustained asymmetric postures and high levels of muscular tension) that can predispose to PRMDs

Six of the musicians interviewed identified poor technique or "bad usage" or "incorrect use" as the major cause of PRMDs. They did not readily identify overuse as a cause, which resonates with earlier debate over nomenclature and the causal relationship suggested by the terminology, that is, "misuse" versus "overuse" (Fry 1986, Hartsell and Tata 1991, Lehrer et al 1993, Rathbone 1986). An interesting point regarding nomenclature was raised by one musician who did not feel comfortable using the word "injury" to describe PRMDs. This musician viewed injury as indicating a severe level of impact on a person's life, that is, "injured people are in hospital", and suggested that "discomfort" was a better way of describing the pain experienced while playing a musical instrument. These points emphasize the importance of ensuring that the language used by the researcher has validity for the participants.

The factor identified by the musicians in Study Two as most likely to prevent PRMDs was "good teaching". Four of the musicians spontaneously used the terms "good teaching" or "good training" initially when discussing how PRMDs could be prevented. The six other musicians did not use these terms explicitly, but discussed factors which form part of the training to play an instrument, including playing technique, the

importance of good posture, the use of instrument supports to minimise excessive muscle tension and abnormal postures, recognition of and methods for dealing with excessive muscular tension, and the role of body awareness in preventing PRMDs. These factors have been identified as having a role in the prevention of PRMDs (e.g. Bejjani et al 1996, Fry 1986a, 1987, Horvath 2001, Keller 2001, Lockwood 1989, Paull and Harrison 1997, Zaza 1994).

The musicians' discussions of excessive muscle tension or physical tension indicated that in this context excessive muscular tension may be defined as muscle activity not required for proficient playing, and which in addition to being a risk factor for PRMDs, may hamper the quality of sound produced. This point is in agreement with the findings of Fry (1986c) and Philipson et al (1990), whose research suggested that a technique which is relatively free of excessive muscle activity is likely to be protective against PRMDs.

The factors which were considered to form an integral part of learning to play an instrument were not always clearly defined. For example, the criteria for good posture were not defined by any of the musicians. Many of the factors discussed were interrelated and in some cases interdependent. For example, while concepts such as good posture and muscle tension could be conceived of as independent entities, good technique incorporates good posture and appropriate levels of muscle tension, as well as other aspects such as technical ability.

A number of different matters relating to posture which had been identified in the literature were also discussed by the musicians, including the use of instrument supports, the need for appropriate seating and the impact of the physical layout of the orchestra and available space. All the violin and viola players reported that instrument supports, in their case chin and shoulder rests, were of paramount importance in mitigating against PRMDs associated with sustained asymmetrical postures. They indicated that while such supports might not resolve an existing PRMD they would certainly contribute significantly to preventing one developing. One musician (who did not play violin or viola) commented that other musicians in the orchestra might regard supports (such as straps or harnesses) for other instruments with suspicion and even derision. However, this opinion was not supported by two string players, who indicated that using a support would be viewed with

understanding by fellow musicians, as a sensible behaviour. Similar findings were reported by Bejjani et al (1996) and Horvath (2001).

The importance of adequate seating in preventing postural loading which might lead to PRMDs was raised by four of the musicians interviewed. This aspect was discussed by Horvath (2001), Kelnar et al (1995) and Owen (1985). Another source of PRMD risk identified by six musicians was crowded or cramped playing conditions, where inadequate space could result in poor posture and awkward playing positions. Cramped pit conditions as a potential risk factor was also discussed by Paull and Harrison (1997). The musicians interviewed discussed the importance of sightlines, that is, the line of sight between the musicians, their music stands and the conductor, in terms of posture. They identified a PRMD risk in situations where the physical layout of the chairs and music stands prevented good sightlines, resulting in the need to sustain awkward postures for prolonged periods.

The interviewees expressed the belief that the incorporation of injury prevention and management advice when training to play an instrument was critical for the prevention and management of PRMDs. Three of the musicians considered that lectures on the subject would not be a successful way of delivering the information. This belief is consistent with the Juilliard experience, where despite 12 years of gradually introducing on-site medical care and injury prevention lectures, student attendance at these lectures was poor, and students and faculty still did not have "an appropriate appreciation of the critical role of injury prevention" (Weiss et al 2000). This finding suggests that alternative ways of teaching and training in injury prevention and management are critical if future generations of musicians are to learn and apply this information.

Although the interviewees did not support classroom style lectures, they suggested that delivering this information is the responsibility of the individual teacher. Teachers were viewed as having a profound influence on how one played, but it was not necessarily always regarded as positive, as the individual teacher could pass on bad habits, as well as good, "often to a student's physical detriment". There was also criticism of the current standards of teaching regarding PRMD prevention as being low because of individual teachers' ignorance. Various aspects of the critical importance of teachers in assisting musicians to develop behaviours which would assist prevention of PRMDs have been

discussed in the literature (Fry 1987, Hagglund 1996, Hartsell and Tata 1991, Nagai and Eng 1992, Palac 1985, Spaulding 1988, Weiss et al 2001, Zaza 1994).

The comments of the musicians interviewed for Study Two suggest that consideration needs to be given to how, when and where individual teachers will learn accurate information about the many facets of PRMD prevention identified in the literature, and also the knowledge of PRMDs that players develop themselves ('players' wisdom'). It is important that consistent, meaningful advice and training are provided which take the individual student and context into account, not just one aspect of playing (e.g. technical performance). A significant factor in trying to institute music education that leads to good technique, including posture that is relaxed and does not result in cumulative injury, is the difficulty of knowing where and how to break into what is essentially a "chicken or egg" situation. Elbaum (1986) was of the opinion that teachers generally fail to adapt their teaching techniques to the unique anatomical features of the individual student. Presumably most teachers believe that their technique is an adequate and appropriate one to be passing on to subsequent generations. Based on the information and comments provided by the musicians interviewed for this study, it would seem that some students unconsciously mimic their teacher's posture and technique. Yet the teacher's technique may not be the most effective one for all students. That assertion is borne out by the number of interviewees who discussed students who had come to them from earlier teachers with what they assessed to be poor postures and techniques, and which they judged as likely to cause problems if not sooner then later. The question raised is whether it is possible to determine if a given teacher is passing on poor technique to all his or her students, or if the technique is simply unsuited to some of the students because of individual variations in the physical relationship with the instrument. If the teacher was routinely passing on poor techniques, then the next issue is whether intervention would be possible, since by the time people are teaching, their own habitual motor responses are presumably extremely well ingrained. If they were not, or had not, personally experienced PRMD as a result of their technique, then the impetus for changing their style of teaching would be minimal.

Considering that when the earliest manifestations of PRMDs occur, that is, in high school musicians, those affected will have been playing for about 10 years, it is imperative at that stage that the cause of the PRMD be identified. Three musicians interviewed emphasised

that observation of the musician needs to be done by an external expert. As interviewees suggested, attempted correction of poor playing biomechanics by self-observation, for example with the use of mirrors, may result in inaccurate feedback because of faulty body image or lack of relevant knowledge.

One cause of PRMDs may be poor playing biomechanics. These motor patterns will have been well established and may therefore be difficult to change. However, one recent study (Sanders 1995) demonstrated that it is possible for swimmers with established, stable stroke patterns to change their style, given appropriate instruction and feedback, both verbal and via video replay of performance. The implications of that study for an injured population, in a complex environment, either at an educational institution or in the workplace, are not known. However, three musicians who were experienced in both teaching and performance emphasized the importance of visual feedback via the use of mirrors and an expert technique analysis, that is, by a teacher with sufficient understanding of body mechanics, including recognition of excessive muscular tension, as well as a thorough grounding in playing technique. Paull and Harrison (1997) also discussed the importance of external feedback in assessing technique to identify potential risk factors for PRMDs. Although the use of videotaping to assist with changing technique for musicians was not mentioned in the literature, its use has been described by one author (Pacelli 1989) as "essential to diagnose primary and compensatory problems in musicians".

Five of the musicians interviewed had positive experiences from interactions with health professionals, for example, physiotherapists and Alexander technique practitioners. Two reported these interactions as being a collaborative process, which is consistent with the role proposed by other authors. Health professionals consulted need to be keen observers and experts in their own field rather than experts on musical technique. For successful treatment and sustained rehabilitation, the skills and knowledge of the different disciplines need to be integrated (Elbaum 1986, Fjellman-Wickland and Sundelin 1988, Hartsell and Tata 1991, Keller 2001, Lehrer et al 1993, Lo Buono 2001, Quarrier 1993, Slade et al 1999, Smith 2001, Spaulding 1988).

The factors under consideration as mediating prevention of PRMDs are presumed to be behaviours learned and entrenched well before employment as a professional musician.

These factors include a good playing technique, which incorporates preventive behaviours learned from one's individual teacher. According to the comments of three of the musicians interviewed, this technique may not be consciously acquired. It is proposed that the behaviours that are within a musician's control (that is, those related to playing the instrument, such as taking practice breaks and planning a gradual build-up of performance endurance) should be well established over the many years required to reach professional level.

The three musicians who discussed the possibility of retraining technique viewed the process as difficult, frustrating and "fairly long and slow", better started at an early age, likely to result in a reduced performance ability initially, and possibly resulting in a reduced "brilliance in doing it" in the long run. The view that changing technique as an older musician would be difficult was also articulated by Hagglund (1996), Lehrer et al (1993) and Spaulding (1988). However, as the case study reported by Lehrer et al (1993) indicates, changing technique is possible with perseverance although it can take many months to achieve. As the views of the musicians interviewed for Study Two suggest, musicians would need initially to be convinced that there would be a long-term benefit, such as career longevity, as a trade-off for the perceived reduction in performance quality which they regard as making them unique, before they would consider undertaking retraining. This condition raises two interrelated issues. The first is that there is a lack of current evidence for career longevity related to changing technique and/or behaviours, and the second is the credibility of the health care professional delivering this type of advice. A number of authors have cautioned against offering advice when the support for it is not well established as having a positive outcome (Marshall and Clare 1987, Zaza 1994).

The three musicians interviewed who stated that they had never experienced a PRMD nominated potential risk factors for PRMDs, based on their own and others' experience. These included (a) being female, (b) asymmetrical postural loading and instrument weight, particularly amongst violin and viola players, and (c) playing with excessive tension, both muscular and psychological. These risk factors have all been identified in the literature (Eller et al 1992, Fishbein et al 1998, Fry 1987, Larsson et al 1993, Lockwood 1988, Revak 1989, Zaza and Farewell 1997, Zetterberg et al 1998).

The musicians who had never experienced a PRMD were also able to suggest strategies that might prevent injuries, such as gradual build-up of strength and endurance in specific muscle groups, and meaningful practice. These strategies were in keeping with published advice (e.g. Paull and Harrison 1997). Whilst these musicians, in common with the other interviewees, nominated good teaching as the basis for career longevity, they also offered additional reasons for the conditions which may have allowed them to sustain pain-free careers. Their explanations included that they were lucky, were male, were physically flexible, and were relatively physically co-ordinated and well balanced.

Aside from good teaching, these comments suggest two explanations for the pain-free careers of these three musicians. The first is that they did not consciously know why they were pain free. They suggested certain physical qualities, but apart from being male, there is no research to support the belief that being well co-ordinated, well balanced or physically flexible contributes to reduced likelihood of developing a PRMD. Hypermobility may confer some benefit to musicians for the joints undergoing repetitive motion, but not for those that are weight bearing (Larsson et al 1993). Consequently, although the comments of the PRMD-free musicians offer clues as to why they may have maintained a pain-free playing career, they do not offer any avenues for intervention by those seeking to prevent or manage PRMDs, since it is difficult to influence luck or being born well co-ordinated.

A second possibility is that there may be other factors which these musicians believed influenced their lack of PRMD, but which were in effect "commercial-in-confidence" and were therefore not revealed even in the confidentiality of the interviews. This explanation requires that we believe that the factors which mitigate against injury are secrets known to a handful of musicians, and this proposition seems highly unlikely, based on other large-scale research involving musicians. On the other hand there is a definite need to explore in greater depth practice-based knowledge, which I have called 'players' wisdom', that was reported and implied in this study. There is a growing body of literature in other fields, particularly the health professions, which attests to and values knowledge derived from experience. This is not simply experience but professional craft knowledge constructed by the processing, testing and reflection upon ideas generated through experience (Higgs et al 2004). This is a potentially vast field of knowledge waiting to be

tapped through articulation and dissemination via teaching and through research grounded in practice wisdom.

Considering the high occurrence of PRMDs reported in the literature (e.g. Fishbein et al 1988, Fjellman-Wiklund and Sundelin 1998, Zetterberg et al 1998), and from the sample surveyed in this study, in conjunction with the evidence regarding expert performance (e.g. Ericsson and Lehmann 1998), it is clear that good playing habits need to be established early in a musician's life to avoid potentially harmful playing-related behaviours becoming automatic, and thus difficult to rectify. According to Spaulding (1988), reliable coping and prevention skills are not difficult for music students to acquire. Rather "the real challenge to the interdisciplinary instructor is in the art of making prevention-consciousness accessible to musicians in meaningful, applied and supportive ways" (Spaulding 1988, p.135)

This study established that the musicians surveyed and interviewed, whether or not they had experienced a PRMD, could clearly identify the factors which they believed would help prevent PRMDs. This outcome is at variance with the opinion of Zaza et al (1998) that little is known about the magnitude of the health problems of musicians, the factors that place musicians at risk, which therapies are effective and appropriate for musicians, and the ways in which musicians can prevent those problems. No common behaviours were identified for the musicians who claimed never to have experienced a PRMD. The common factor nominated by all of the musicians as conferring prevention of PRMDs was "good teaching".

In summary, there were five key themes identified in this study:

- PRMDs are frequently preventable
- Good early training is a key way of preventing PRMDs
- Player wisdom is important in preventing and managing PRMDs
- Contextual factors often contribute to PRMDs
- Management and re-training can alleviate PRMDs

These findings provide rich material for further investigation and implications for teaching and playing, which are discussed in the next chapter.

CHAPTER 5

CONCLUSION

5.1 Summary of Major Outcomes

This research sought to access the experience, knowledge and beliefs of practising professional musicians regarding the prevention and management of PRMDs to provide another perspective on this important topic, as the majority of the preventive advice previously offered to musicians by health professionals had been based on data generated from their clinical experience with injured populations. This research aimed to explore whether the advice proffered by other authors regarding the prevention of PRMDs was accepted by musicians, whether they complied with that advice or if there were any other identifiable behaviours which they believed could prevent PRMDs. Study One primarily used a quantitative survey approach, while Study Two used a qualitative method to further explore the points raised regarding PRMDs prevention by the musicians who responded to Study One.

An important outcome of this research was that the musicians surveyed for Study One, and those interviewed for Study Two said that they believed it is possible to prevent or substantially minimise the occurrence of PRMDs. There were two key factors identified that these musicians believed could enhance the possibility of preventing and minimising PRMDs. These were early training in good playing technique and in PRMD prevention, and the development by musicians of their own experience-based knowledge or "playing wisdom" that enables them to understand the key factors leading to PRMDs, particularly the use of their instrument, their playing technique and their own body/posture in relation to playing. The Study Two musicians (whether or not they had ever experienced a PRMD) indicated that PRMDs could be prevented by "good teaching". These musicians found from their extensive playing experience and interactions with other musicians and teachers that minimising excessive muscle tension during playing was an important factor in preventing PRMDs.

Good teaching, or good training, from an early playing age was identified by the musicians in both studies as having an important role in the prevention of PRMDs. The Study One questionnaire allowed only limited possible responses to a range of matters,

but did allow the musicians to provide personal responses regarding the advice which they believed to be important to include in training to prevent PRMDs. Four of the twenty-eight musicians in Study One explicitly nominated good teaching from an early age as an important factor in training to help disruptions to performance or practice later in one's career. The other factors nominated, such as postural awareness or good posture, playing efficiently, training in stretching, taking regular breaks during practice and the use of appropriate seating were part of their "player's wisdom" and ideally should be integral components of a programme of training to play a musical instrument. To further explore the issues raised in the questionnaire, a semistructured interview was developed.

All of the musicians interviewed for Study Two held the opinion that PRMDs can be prevented or substantially minimised by "good" teaching or training. The responses of the musicians were similar to those of the musicians surveyed for Study One. That is, some musicians spontaneously used the terms "good" teaching or training, and all discussed factors which form an integral part of the training to play an instrument, including playing technique, the importance of good posture, the use of instrument supports to minimise excessive muscle tension and abnormal postures, recognition of, and methods for dealing with excessive muscle tension, and the role of body awareness in preventing PRMDs. However, some of these musicians also observed that not all teachers passed on effective preventive skills and strategies. They reported that some teachers actually passed on detrimental skills, by not even recognising when a student was "tied up in knots", that is, the teachers lacked knowledge, understanding and recognition of abnormal body tension and posture and effective means of dealing with them.

Across the participant group there was a considerable variation in what and how they were taught as students about the prevention of PRMDS. The musicians surveyed for Study One reported a number of different sources of information regarding the prevention of PRMDs which they had used. The sources included learning about injury prevention from their individual teacher, from a health professional, for example a physiotherapist or Feldenkrais practitioner, from fellow musicians and learning this sort of information at university, as part of course work, or from a workshop. Eleven reported that they had never received any formal information, but had worked out strategies for themselves. By contrast all of the musicians interviewed for Study Two, ranging from 18 to 64 total years of playing an instrument, were emphatic in their comments that they were never formally

taught about injury prevention by anyone at the institutions they attended during their studies, either in high school or at tertiary level. They regarded receiving instruction from a teacher, in individual lessons, on how to prevent injury as occurring only by the chance. It was also apparent from their discussions that what they taught their own students, and the manner in which they did so, was not consistent across these musicians.

It would seem that despite repeated pleas in the literature (Fry 1984, Hagglund 1996, Hartsell and Tata 1991, Nagai and Eng 1992, Palac 1985, Weiss et al 2001, Zaza 1994) for recognition of the magnitude of the problem of PRMDs and requests for appropriate education at all levels, little has changed over the period that the musicians interviewed for Study Two were learning to play or in their current roles as professional musicians and music educators.

The musicians interviewed for Study Two identified high workloads (quantity of work), and excessive practice as being most likely to place them at the risk of developing a PRMD. Two of the musicians who responded to Study One advised that excessive workloads should be avoided to prevent PRMDs. However the important concept of what constitutes a high workload was not able to be determined from these studies. Defining this concept is problematic (see Chapter 4) because of individual variations in physical tolerance for a given activity. Thus a given workload may place one musician at risk of developing a PRMD but not another. Nonetheless, this is a crucial area for further exploration to extend understanding of how to prevent PRMDs. One way of defining the parameters of excessive workload might be in terms of physical response, such as pain or other symptoms persisting beyond a certain time frame. An example of this definition is the grading system previously discussed (see Fry 1986a, 1986b, 1986c, Bird 1989, Paull and Harrison 1997), with Grade 1 representing mild, transient symptoms, through to Grade 5 representing severe symptoms at multiple sites associated with loss of function. It is important for transient pain, which may develop during training to play an instrument or periods of learning technically challenging pieces, to be clearly understood by health professionals, music educators, students and professional musicians, to limit the likelihood that Grade 1 symptoms worsen.

The musicians in both studies highlighted the role of muscle tension in PRMDs. The musicians surveyed for Study One nominated relaxing the muscles not required during

playing an instrument in order to prevent PRMDs as an important piece of advice to pass onto young musicians starting their careers. Playing with excessive muscle tension was viewed as a cause of muscular discomfort, or more serious PRMDs, by the musicians interviewed for Study Two. The musicians in Study Two who were also experienced teachers held the opinion that it is possible to predict which students are likely to experience PRMDs, and that they would be alerted to this possibility if they were to observe excessive muscle tension in specific body areas or overall posture in a student. These musicians also indicated that analysis of any excessive tension, pain or discomfort was vital for isolating the source of a PRMD, and then being able to change it, both for students and experienced professionals.

The musicians in Study Two indicated that while retraining playing technique as an adult is regarded as possible, it is seen as difficult and arduous. This viewpoint is consistent with the work of earlier authors (e.g. Hagglund 1996, Lehrer et al 1993). The earliest manifestations of PRMDs occur in high school musicians, when those affected will have been playing for about 10 years. Therefore, it is imperative that at this early stage the cause of the student musician's PRMD is accurately identified, and an appropriate management plan instituted, including self-management, to allow the student the best possible chance of changing relevant behaviours to promote avoidance of PRMDs and enhance career longevity. The Study Two musicians emphasised that observation and analysis of a musician's playing technique or posture needs to be done by an expert external observer. The reason put forward for this was that attempted correction of poor playing biomechanics or posture by self-observation, for example with the use of mirrors, may result in inaccurate feedback because of faulty body image.

The present participants' belief in the preventability of PRMDs does seem to be incongruent with the continued reporting in the literature (e.g. Fishbein et al 1988, Zaza 1998) of high occurrences of PRMDs. In other words, if these practitioners believe that minimisation of PRMDs is possible, then why do a high proportion of musicians continue to report that they experience PRMDs? This research sheds some light on this question in that the participants identified a number of factors which restricted their willingness or opportunity to avoid, minimise or seek treatment for PRMDs. Such factors included aspects of the physical environment that were beyond their control (such as overcrowding in orchestra pits) and a number of factors related to the culture and climate of the "music

world" (e.g. an expectation of stoicism and the fear of losing working and shortening their careers if injuries are made known) that basically emphasised "the show must go on" rather than "how can musicians be supported in a healthy, long career?".

In summary, the advice offered by the musicians in both studies suggests that effective prevention of PRMDs requires a multi-faceted approach, which includes teaching, self-management and changes in organisations and culture. Firstly, the musicians in both studies emphasised the important role of sound early teaching or training in PRMD prevention. Training to play a musical instrument encompasses a wide range of elements, including playing technique, posture, use of appropriate instrument supports and effective practice habits. The role of the individual teacher was viewed as paramount in the acquisition of preventive behaviours, even if these were passed on via demonstration rather than being articulated by the teacher.

Secondly, some aspects of the factors believed to cause PRMDs, such as quantity of playing, lie within the individual musician's control. For example, both music students and professional musicians can control the quantity, pacing and timing of practice sessions. However, an orchestrally-employed musician is not likely to have any control over performance scheduling. Such issues could be the focus of industrial bodies. Other factors perceived to contribute to PRMDs, such as playing posture, level of muscle tension in different body areas during playing or the use of appropriate instrument supports are directly within the individual musician's control, but may require expert advice and external feedback to implement effective, sustained behaviours, that is, ones protective of PRMDs. Other factors such as orchestra pit size and layout and available seating may be difficult for individual musicians to influence and require organisation/system level and industrial intervention.

The belief that one of the causes of PRMDs, that is, musicians' workloads, has increased over the previous twenty years and requests for appropriate education at all levels, from student to professional, were identified in the literature. However, it would seem that despite the continued reporting of such high proportions of musicians experiencing PRMDs that there has not been any evident move towards an emphasis being placed on this important, potentially career-threatening issue.

5.2 Critique of this research

As discussed above, a principal strength of this research was that it provided the opportunity to explore the knowledge, beliefs and opinions regarding the prevention and management of PRMDs held by two groups of professional musicians who had successfully sustained careers and had experience of full-time orchestral employment. By contrast, previous literature has primarily reported on these matters from the point of view of health professionals and music educators. Many of the findings of this research, for example the causes of PRMDs identified by these musicians and the preventive advice offered, are consistent with the advice offered by earlier authors (e.g. Fry 1084, Nagai and Eng 1992, Owen 1985, Paull and Harrison 1997, Zaza and Farewell 1997). A new emphasis in this research is the acknowledgement of "player's wisdom" or the professional craft knowledge which can facilitate PRMD prevention and recovery. Such knowledge needs to be further examined to bring it from the level of tacit understanding to publicly available, teachable and testable (through further research) knowledge.

Limitations of this research were identified in both Study One and Study Two. A number of issues were raised in relation to Study One. There was a low return rate (less than thirty percent) and low absolute number of respondents (twenty eight). This can be attributed to a number of factors, including the lack of personal contact between the researcher and the musicians, a situation determined by management. The extent to which the data was biased towards respondents who had experienced a PRMD and were motivated to respond cannot be established, as no information was available regarding those who did not respond.

Although believed to be high, the true occurrence of PRMDs has still not been convincingly established. Most questionnaire studies identified in the literature had a return rate well under fifty percent, and no information was available regarding those who did not respond. For example, it is not known if non-respondents never experienced PRMDs, or had, but did not wish to respond for a number of reasons. These reasons might include fear of their condition becoming known, which could have an effect on the amount of work they might be offered once their professional reputation had been potentially marked as unreliable. Study One lacked the statistical power to significantly contribute to this area of knowledge.

A number of studies surveyed close to whole populations, such as ninety percent of an entire orchestra or music school, and these were able to demonstrate high levels of prevalence of PRMDs. However, the literature was not always precise in defining what exactly was being studied. Zaza and Farewell (1997) produced an operational definition of PRMDs, one feature of which was that the injury was of sufficient magnitude to interfere with the musician's ability to play. Other studies included a more imprecise definition of injury, ranging from aches and pain through to severe and disabling pain, but did not necessarily report on the differences, on the impact of the severity on a musician's ability to continue playing, in a meaningful way. The current research did not attempt to define PRMDs, as the focus was on the professional craft knowledge regarding the prevention and management of PRMDs of those who had successfully maintained careers as professional musicians.

The high proportion of musicians in Study One who reported experiencing PRMDs of severity sufficient to result in them taking time off work on more than one occasion appeared to be consistent with other studies which had adjusted statistics to exclude mild and transient symptoms from their data (Fry 1986a, Zaza 1998). The small absolute number of respondents (twenty-eight) did not allow for meaningful statistical analyses of the data, including cross tabulations, to be performed. Requesting written responses regarding information about how to prevent PRMDs allowed insight into what these musicians perceived to be important in this matter.

Ten musicians were interviewed in Study Two. Again, the small number of musicians did not allow for meaningful statistical analyses of the data nor was the (qualitative) research design intended to produce quantitative results. The nature of the interviews, that is, using a semistructured format, presented both advantages and disadvantages. This format allowed the flexibility to explore any matters raised by the musicians interviewed. Conversely, that degree of freedom which allowed a deeper exploration of the musicians' knowledge, experience and opinions, that is, professional craft knowledge, meant that some issues were only discussed by one or two participants. This diffusion of topics allowed for comment and interpretation, rather than generalisation of findings. From a practical point of view this method of data analysis is also time-consuming, and the researcher's own background knowledge and experience influences the analysis.

5.3 Implications for future research

A number of different areas which would benefit from further exploration to assist in developing a more thorough understanding of how to prevent and manage PRMDs were suggested by the findings of the current research. The concept of optimal posture needs to be explored and more clearly defined to enhance musicians' and music educators' understanding of what is an appropriate posture in terms of playing the range of musical instruments. It is proposed that in this exploration routinely adopting terminology such as "optimal posture", rather than "good posture" would shift postural conceptualisation away from a rigid ideal towards a dynamic concept, which encapsulates the ergonomic considerations of playing a particular instrument. Thus, optimal posture could be described in terms of a set of principles, such as maintaining the most symmetrical posture possible in relation to the instrument played, rather that in absolute terms, such as maintaining certain positions of the head, shoulders and spine. This point is germane for musicians because of the wide variations in postures required to play different instruments. For example, posture at the piano can be symmetrical, whereas by the very nature of instruments such as violin, viola and cello an asymmetrical posture must be adopted. Establishing optimal posture for an individual musician would also need to take account of considerations such as appropriate seating, and the use of instrument supports such as chin or shoulder rests to minimise the short and long term musculoskeletal effects of asymmetrical postural loading.

The second area which requires further exploration for musicians and music educators is the concept of muscle tension. As noted, the musicians interviewed for Study Two believed that they could predict which of their students might be likely to experience a PRMD at a later stage of their career. They indicated that they would be alerted to this possibility by observing excessive muscle tension in certain areas of the body. The notion of "excessive" muscle tension needs to be made explicit in order to assist in recognising when PRMDs are likely to occur. Methods of minimizing muscle tension, so that only the necessary tension required to play is used, need to be explored and evaluated. This area of research presents an opportunity to integrate the knowledge, skills and understanding of musicians with that of health professionals skilled in musculoskeletal analysis, such as physiotherapists.

An important area for exploration is investigating the nature and effectiveness (in terms of appropriate behaviour changes) of alternative methods of training music students and professional musicians about injury prevention and management. Based on the reports in the literature, for example the experience over twelve years at the Juilliard School in New York (Weiss et al 2000), and the opinions of the musicians interviewed in Study Two it seems apparent that formal lectures in injury prevention and management for musicians are not regarded as a priority by music students or music educators, and thus are not an effective form of education. Identifying effective alternative methods of teaching and training in injury prevention and management is critical if future generations of musicians are to learn and apply this information.

The Study Two musicians who were experienced in both teaching and performance emphasised the important role of visual feedback (for example via the use of mirrors) combined with an expert analysis of the player's technique in establishing and maintaining desired postures and technique. A further area which requires investigation is whether visual feedback via the use video recordings has a role in assisting musicians to change technique if required. Although Pacelli (1989) described the use of videotaping as "essential to diagnose primary and compensatory problems" in musicians, no research was identified which examined or evaluated this proposal. Sanders' (1995) research with nine masters[1] swimmers indicated that they were able to change well-established and stable movement patterns for conventional breaststroke technique using a combination of coaching sessions and video feedback. It is not known how this information might translate to changing the skills involved in playing an instrument, as the complexity of inter-related fine and gross motor skills required to play most musical instruments is greater than the gross motor movements required for breaststroke. Additionally there may be a significant psychological component involved when a musician seeks to learn a new technique and simultaneously deal with the range of consequences associated with an injury.

The following possibilities could be research topics for those concerned with maintaining the health of musicians. In the non-injured population, such as students in their early years of training, the use of video feedback as part of the teaching process could be

assessed for efficacy in assisting faster modification toward "good technique". In an injured population where poor playing biomechanics is identified as the precipitating cause of the PRMD, video could be studied for efficacy in establishing and maintaining new, pain-free playing patterns.

Talent notwithstanding, music making is grounded in automated behaviour. It can be argued that a firmly established technique frees the musician to use his or her available conscious control for the task of musical interpretation and the minute technical variations which differentiate the average proficient professional from the musician regarded by both peers and the listening public as a virtuoso. The theory relating to the automaticity of skill acquisition could be relevant to research into the process of changing technique, as it would seem that explicating certain aspects of a complex motor skill results in an initial degradation of the skill execution. The Study Two musicians referred to this phenomenon when they discussed the difficulty of changing technique, which was viewed as a slow, and psychologically painful process in terms of frustration. As discussed in Chapter 4 there are two areas which require further consideration regarding this matter. The first is the current lack of evidence to support career longevity related to changing techniques and/or behaviours, and the second is the question of the credibility of health care professionals rather than musicians delivering this type of advice. It would seem important that both these areas be explored to improve the prevention of PRMDs.

5.4 Implications for Training and Work of Orchestral Musicians

In terms of the implications of this research relating to the training and work of orchestral musicians, a number of areas of importance are suggested. The responses of the musicians surveyed and interviewed, and information from previous research suggest that there are two broad areas from which to choose the range of possible effective options relating to the prevention and management of PRMDs. These are: factors which lie within an individual musician's control, such as practice behaviours including choices about performing a musical warm up, practice habits, the types of exercises pursued and technique; and factors which largely fall outside that control for an orchestrally employed musician, for example performance scheduling.

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[1] Masters swimmers are defined (by Sanders 1995) as those over the age of 25 who train and compete with each other.

Quantity of playing was identified as one of the main causes of PRMDs by the musicians interviewed from Study Two. As the quantity of playing lies partly within the individual musician's control, for example by judicious timing and pacing of practice sessions, part of the challenge for music educators would therefore seem to be how to best instil sound practice habits (e.g. rests, warm-ups, scheduling and duration of practice sessions, gradually increasing practice after breaks from playing) in music students (and music teachers!). This advice has been repeatedly put forward in the literature, as a means of preventing and managing PRMDs. For example, Fry (1984, p.60) asserted that "considerable discipline with practice habits must prevail" to avoid recurrence of PRMDs. A similar point was made by Spaulding (1988, p.135), who developed a preventive program at a music conservatory which was centred on motivating and instructing students "so that they can monitor their own practice and playing habits".

The Study Two musicians discussed a number of reasons why they might continue to practice despite experiencing fatigue or pain, including a sense of bravado, for example at music camps, or the sensation that they were on the verge of mastering a difficult passage or piece of music. Consistently achieving appropriate practice behaviours with music students is a challenging issue. Gollwitzer's (1999) research into the effects of implementation planning on goal attainment has relevance to this topic.

Beyond defining the parameters of excessive muscle tension and educating musicians and music educators in this matter, prevention and management of PRMDs requires at least an awareness of possible rectifying actions. These actions might include referral to an appropriately experienced health professional. As noted in the literature, integration of the expertise of musicians and health professionals will be required to produce an effective management plan for prevention and management of PRMDs.

Industrial issues, such as the workload required of an employed musician, fall outside the scope of this thesis. However, this is a very important area for ongoing consideration. As previously noted, the quantity of work or amount of playing was identified by the majority of musicians in Study Two as one of the main causes of PRMDs. The quantity of work undertaken by an orchestra must balance a number of considerations, including financial as well as artistic aspects. The quantity of work which is likely to constitute a PRMD risk has not yet been established. In any case, considering the multi-factorial

nature of PRMDs, it is unlikely that such a quantity could be specified for a number of reasons. These include the variations in individual responses to a given workload. It is also worth considering that the overwhelming majority of employed musicians who took part in this research maintained full-time workloads despite high proportions reporting experiencing some degree of PRMD. Clearly if a number of musicians within an orchestra are reporting experiencing PRMDs in relation to a particular work, or performance scheduling, then it is appropriate to commence discussions with management through the appropriate channels.

5.5 Conclusion

The major finding from this research is that experienced professional musicians consider, and in their experience have found, that PRMDs can be largely preventable if three key factors are addressed. The first of these is good early teaching which includes sound technique training and helping student musicians learn to monitor their own technique and playing-related behaviours including posture, management of muscle tension during playing and appropriate self-management of playing workload. This would include appropriate build up of workload after time away from playing, rest breaks during practice sessions and appropriate preparation for special events and intensive performance schedules. The second factor is the musician acquiring a depth of experience-based knowledge which the literature refers to as professional craft knowledge and which in this thesis I have labelled "player's wisdom". The third factor is the effective and appropriate management of performance environment conditions. That is, the musicians were strongly of the opinion that a number of environmental factors outside of their control (particularly layout of orchestra pits and required performance schedules) significantly impact on the occurrence and the capacity to remediate PRMDs. The musicians in both studies considered that given good management of all of the above factors PRMDs are largely preventable.

This research sought to access musicians' professional craft knowledge regarding the prevention and management of PRMDs, with the intention that such information about the reality of musicians' working lives can help with understanding how best to prevent and manage PRMDs. The responses of the musicians in both studies indicated that the basis of career longevity rests on sound early training and the development and use of their own player's wisdom to optimise both production of music and at the same time

PRMD prevention. Their responses also indicated agreement with the causes of PRMDs identified by other researchers.

A number of areas for future research were suggested by the musicians' responses. It appears that minor aches and pains or discomfort are a common feature for those using the upper extremities intensively in their work, including occupational groups such as musicians and manual physiotherapists; and that such symptoms may not significantly impact on their ability to continue working. Nonetheless, the occurrence of PRMDs in musicians is uniformly reported as high even when adjusted for minor aches, pains and transient discomfort, and does not appear to have reduced over the years. The effects of PRMDs can be professionally, financially and emotionally devastating for both student and professional musicians, yet this research suggests that much of the effort by those concerned with musicians' health is effectively "after the event", with the genesis of the problem being in early teaching. The critical concept of sound early teaching needs to be clearly defined to assist music educators and health professionals in the prevention and management of PRMDs.

REFERENCES

Ackermann B, Rogers A, Marshall E (2002): The effect of scapula taping on electromyographic activity and musical performance in professional violinists. *Australian Journal of Physiotherapy* 48(3): 197-203.

Alonso A, Khoury L, Adams R (1998): Clinical tests for ankle syndesmosis injury: reliability and prediction of return to function. *Journal of Orthopaedic and Sports Physical Therapy* 27(4): 276-284.

Andrews K (1991): The limitations of randomized controlled trials in rehabilitation research. *Clinical Rehabilitation* 5: 5-8.

Bargh JA, Chartrand TL (1999): The unbearable automaticity of being. *American Psychologist* 54 (7): 462-479.

Bejjani FJ, Kaye GM, Benham MB (1996): Musculoskeletal and neuromuscular conditions of instrumental musicians. *Archives of Physical Medicine and Rehabilitation* 77: 406-413.

Bird H (1986): Overuse syndromes in musicians. Letter in *The Lancet* October 18: 916.

Bird H (1989): Overuse injuries in musicians. Letter in *British Medical Journal* 298 (April): 1129-130.

Bond J (1997): Course Notes, Australian Institute of Sport, Sport Psychology Department: Using mental practice for better performances.

Borg G (1990): Psychophysical scaling with applications in physical work and the perception of exertion. *Scandinavian Journal of Work and Environmental Health* 16: 55 - 58.

Brandfonbrener AG (1988): The Price of Perfection. Editorial in *Medical Problems of Performing Artists* March 1988.

Chan RFM, Chow C, Lee GPS, To L, Tsang XYS, Yeung SS, Yeung EW (2000): Self-perceived exertion level and objective evaluation of neuromuscular fatigue in a training session of orchestral violin players. *Applied Ergonomics* 31: 335-341.

Charness ME, Ross MH, Shefner JM (1996): Ulnar neuropathy and dystonic flexion of the fourth and fifth digits: clinical correlation in musicians. *Muscle and Nerve* April: 431-437.

Drake J (1993): *Thorsons Introductory Guide to the Alexander Technique*: Chapters 1-3. London: Harper Collins.

Edwards T, Kingston K, Hardy L, Gould D (2002): A qualitative analysis of catastrophic performances and the associated thoughts, feelings and emotions. *Sport Psychologist* 16: 1-19.

Elbaum L (1986): Musculoskeletal problems instrumental musicians. *The Journal of Orthopaedic and Sports Physical Therapy* 8(6): 285-287.

Eller N, Skylv G, Ostri B, Dahlin E, Suadicani P, Gyntelberg F (1992): Health and lifestyle characteristics of professional singers and instrumentalists. *Occupational Medicine* 42(2): 89-92.

Ericsson KA, Lehmann AC (1996): Expert and exceptional performance: evidence of maximal adaptation to tasks constraints. *Annual Review of Psychology* 47: 273-305.

Ericsson KA, Smith J (1991): Prospects and limits of the empirical study of expertise: an introduction. In KA Ericsson and J Smith (eds), *Toward a general theory of expertise. Prospects and limits* (1-37). Cambridge: Cambridge University Press.

Fishbein M, Middlestadt SE, Ottati V, Straus S, Ellis A (1988): Medical problems among ICSOM musicians: overview of a national survey. *Medical Problems of Performing Artists* 3: 1-8.

Fjellman-Wiklund A, Sundelin G (1998): Musculoskeletal discomfort of music teachers: an eight-year perspective and psychosocial work factors. *International Journal of Occupational and Environmental Health* 4(2): 89-98.

Friedman P (1998): Focal dystonia in a musician. Letter in *Manual Therapy* 3(2): 108-109.

Fry HJH (1984): Occupational maladies of musicians: their cause and prevention. *International Journal of Music Education* 2: 59-63.

Fry HJH (1986a): Overuse syndrome of the upper limb in musicians. *Medical Journal of Australia* 144: 182-185.

Fry HJH (1986b): Incidence of overuse syndrome in the symphony orchestra. *Medical Problems of Performing Artists* June 1986: 51-55.

Fry HJH (1986c): Overuse syndrome in musicians: prevention and management. *The Lancet* September 27: 728-731.

Fry HJH (1987): Prevalence of overuse (injury) syndrome in Australian music schools. *British Journal of Industrial Medicine* 44: 35-40.

Genaidy AM, Karwoski W, Guo L, Hidalgo J, Garbutt G (1992): Physical training: a toll for increasing work tolerance limits of employees engaged in manual handling tasks. *Ergonomics* 35 (9): 1081 - 1102

Gladwell M (2000, November 11): When it comes to the crunch. *Sydney Morning Herald*: *Good Weekend Magazine*: 50-54.

Gollwitzer PM (1999): Implementation effects. Strong effects of simple plans. *American Psychologist* 54 (7): 493-503.

Grahame R (1993): Joint hypermobility and the performing musician. *New England Journal of Medicine* 329: 1120-1.

Hagberg M (1981): Electromyographic signs of shoulder muscular fatigue in two elevated arm positions. *American Journal of Physical Medicine* 60(3): 111-121.

Hagglund KL (1996): Practicing prevention in the music schools. *Work* 7: 139-140.

Hanton S, Jones G (1999): The acquisition and development of cognitive skills and strategies: I. Making the butterflies fly in formation. *Sport Psychologist* 13: 1-21.

Harste AM (1990): "Tuning" musicians? *The Physician and Sportsmedicine* 18(12): 16.

Hartsell HD, Tata GE (1991): A retrospective survey of music-related musculoskeletal problems occurring in undergraduate music students. *Physiotherapy Canada* 43(1): 13-18.

Hergenhahn BR (1997): After Aristotle: a search for the good life. In *An Introduction to the History of Psychology* (3rd ed.): 55-59. New York: Brooks/Cole Publishing Company:.

Higgs J and Titchen A (1995) The nature, generation and verification of knowledge. *Physiotherapy* 81: 521-530.

Higgs J, Fish D, Rothwell R (2004): Practice knowledge – critical appreciation. In J Higgs, B Richardson and M Abrandt Dahlgren (Eds), *Developing Practice Knowledge for Health Professionals*: 89-105. Oxford: Butterworth Heinemann.

Higgs J, Titchen A, Neville V (2001): Professional practice and knowledge. In J Higgs and A Titchen (Eds), *Practice Knowledge and Expertise in the Health Professions*: 3-9. Oxford: Butterworth Heinemann.

Horvath J (2001): Playing less hurt: an orchestra musician's perspective on 20 years of performing arts medicine. *Proceedings of the Nineteenth Annual Symposium on Medical Problems of Musicians and Dancers, Aspen, Colorado* June 21-24: 5-16.

Howe MJA, Davidson JW, Sloboda JA (1998): Innate talents: reality or myth? *Behavioural and Brain Sciences* 21: 399-442.

Hutson MA (1997: *Work-related Upper Limb Disorders: Recognition and Management.* Oxford: Butterworth Heinemann.

Keller K (2001): Performing arts medicine at the Juilliard School: the physical therapy component. *Proceedings of the Nineteenth Annual Symposium on Medical Problems of Musicians and Dancers, Aspen, Colorado.* June 21-24: 5-16.

Kelnar AF, Ives J, Lambert CM (1995): Musical chairs: ergonomic considerations in chair design. *British Journal of Therapy and Rehabilitation* 2(1): 17-21.

Kember JM, (1997): Focal dystonia in a musician. *Manual Therapy* 2(4): 221-225.

Kivimaki M, Jokinen M (1994): Job perceptions and well-being among symphony orchestra musicians: a comparison with other occupational groups. *Medical Problems of Performing Artists* Sept 1994: 73-76.

Kvale S (1996): InterViews. *An Introduction to Qualitative Research Interviewing.* Thousand Oaks, CA: Sage Publications.

Larsson LG, Baum J, Mudholkar GS, Kollia GD (1993): Benefits and disadvantages of joint hypermobility among musicians. *New England Journal of Medicine* 329(15): 1079-82.

Lehrer S, Weiss J, Kark P (1993): Misuse syndrome in musicians: combined medical and musical approach. In Bejjani FJ (ed): *Current research in arts medicine.* 365-7. Chicago: A Capella Books.

Lo Buono C (2001): Musculoskeletal injuries in performing artists. *Patient Care* 35(8): 25-31.

Lockwood AH (1989): Medical problems of musicians. *New England Journal of Medicine* 320(4): 221-227.

Mandel S (1990): Overuse syndrome in musicians. When playing an instrument hurts. *Postgraduate Medicine* 88(2): 111-114.

Marshall E, Clare H (1987): Pain – a musician's plight. *Proceedings, Tenth International Congress World Confederation for Physical Therapy, Proceedings Book 1:* 31-35.

Masters RSW (1992): Knowledge, knerves and know-how: the role of explicit versus implicit knowledge in the breakdown of a complex motor skill under pressure. *British Journal of Psychology* 83: 343-358.

Minichiello V, Aroni R, Timewell E, Alexander L (1999). *In-depth Interviewing: Principles, Techniques, Analysis* (2nd ed.). South Melbourne, Australia: Longman.

Muggleton JM, Allen R, Chappell PH (1999): Hand and arm injuries associated with repetitive manual work in industry: a review of disorders, risk factors and preventative measure. *Ergonomics* 42(5): 714-739.

Mustonen O (2003, March: 11): Secret pianists' business. *Australian Financial Review*: 14

Nagai L, Eng J (1992): Overuse injuries incurred by musicians. *Physiotherapy Canada* 44(1): 23-30.

Nagel JJ (1998): Injury and pain in performing musicians: a psychodynamic diagnosis. *Bulletin of the Menninger Clinic* 62(1): 83-94.

National Occupational Health and Safety Commission (1994): National Code of Practice for the Prevention of Occupational Overuse Syndrome [NOHSC: 2013 (1994)], Australian Government Publishing Service: Canberra.

Norris RN (1996): Return to play after injury: strategies to support a musician's recovery. *Work* (7): 89-93.

O'Dwyer NJ, Neilson PD (2000): Metabolic energy expenditure and accuracy in movement: relation to levels of muscle and cardio-respiratory activation and the sense of effort. In W Sparrow (ed), *Energetics of Human Activity*: 1-42. Illinois: Human Kinetics.

Occupational Health and Safety Act 2000 No. 40 (New South Wales): Part 2. Sydney: New South Wales Government Printing Service.

Occupational Health and Safety Regulation 2001 (New South Wales): Chapter 2: Places of work – risk management and other matters. WorkCover, NSW. Sydney: New South Wales Government Printing Service.

Olrich TW, Ewing ME (1999): Life on steroids: bodybuilders describe their perceptions of the anabolic-androgenic steroid use period. *Sport Psychologist* 13: 299-312.

Owen ER (1985): Instrumental musicians and repetition strain injuries. *Journal of Occupational Health and Safety-Australia and New Zealand* 1(2): 135-9.

Pacelli LC (1989): Musicians can benefit from physical tune-up. *Physician and Sportsmedicine* 17(7): 21,24.

Palac J (1995): Prevention of musical injuries: how research can help. *American String Teacher* Spring: 69-72.

Papsin BC, Maaske LA, McGrail JS (1996): Orbicularis oris muscle injury in brass players. *Laryngoscope* 106:757-760.

Patton MQ (1990): *Qualitative Evaluation and Research Methods* (2nd ed). Newbury Park, CA: Sage.

Paull B, Harrison C (1997): *The Athletic Musician. A Guide to Playing Without Pain.* London: The Scarecrow Press.

Philipson L, Sorbye R, Larsson P, Kaladjev S (1990): Muscular load levels in performing musicians as monitored by quantitative electromyography. *Medical Problems of Performing Artists* June: 79-82.

Priori A, Presenti A, Cappellari A, Scarlato G, Barbieri S (2001): Limb immobilization for the treatment of focal occupational dystonia. *Neurology* 57 August (1 of 2): 405-409

Quarrier NF (1993): Performing Arts Medicine: The musical athlete. *The Journal of Orthopaedic and Sports Physical Therapy* 17(2): 90-95.

Rathbone J (1986): Overuse syndromes in musicians. Letter in *The Lancet* October 18: 916.

Revak JM (1989): Incidence of upper extremity discomfort among piano students. *American Journal of Occupational Therapy* 43(3): 149-154.

Rosen C (2000, July 12): Pumping ivories. *The Australian*: Higher Education supplement.

Sanders RH (1995): Can skilled performers readily change technique? An example, conventional to wave action breaststroke. *Human Movement Science* 14: 665-679.

Scott D (1990): Practice wisdom: The neglected source of practice research. *Social Work* 35(6): 564–8.

Shafarman S (1997): *Awareness heals: the Feldenkrais method for dynamic health.* Reading, MA: Addison-Wesley.

Slade JF, Mahoney JD, Dailinger JE, Baxamusa TH (1999): Wrist and hand injuries in musicians: management and prevention. *Journal of Musculoskeletal Medicine* 16(9): 542-552.

Sloboda J (1991): Musical expertise. In: KA Ericcson and J Smith (eds). *Toward a General Theory of Expertise. Prospects and Limits:* (153-171). Cambridge: Cambridge University Press.

Smith CL (2001): Performing arts. *PT Magazine* February 2001: 64-69.

Sparrow WA, Newell KM (1998): Metabolic energy expenditure and the regulation of movement economy. *Psychonomic Bulletin and Review* 5(2): 173-196.

Spaulding C (1988): Before pathology: prevention for performing artists. *Medical Problems of Performing Artists* 3 (1): 135-139.

Stein GM (1973): Children's reactions to innocent victims. *Child Development* 44: 805-810.

Strean WB (1998): Possibilities for qualitative research in sport psychology. *Sport Psychology* 12: 333-345.

Titchen A, McIntyre D (1993): A phenomenological approach to qualitative data analysis in nursing research. in Titchen A (ed): *Changing Nursing Practice Through Action Research.* Oxford: National Institute for Nursing, Centre for Practice Development and Research: Report No. 6: 29-48.

Titchen A and Ersser SJ (2001): The nature of professional craft knowledge. In J Higgs and A Titchen (Eds), *Practice Knowledge and Expertise in the Health Professions*: 35-41. Oxford: Butterworth Heinemann.

Tse S, Yeats M (2002): What helps people wit bipolar affective disorder succeed in employment: a grounded theory approach. *Work* (19): 47-62

Turner-Stokes L, Reid K (1999): Three-dimensional motion analysis of upper limb movement in the bowing arm of string-playing musicians. *Clinical Biomechanics* 14: 426-433.

Van Hees OS (1997): Physical exercise as prevention for musculoskeletal problems in musicians: a panacee demasque. *Proceedings of the British Association for Performing Arts Medicine: "Health and the Musician" Conference, York, United Kingdom*: A1.20-A1.30.

Weiss DS, Keller K, Amdursky AS (2001): Performing arts medicine at the Juilliard School: twelve years of progress. *Proceedings of the Nineteenth Annual Symposium on Medical Problems of Musicians and Dancers, Aspen, Colorado*: June 21-24: 1-4.

Wilkinson M, Grimmer K (2001): Ultrasound of the left shoulder girdle in professional violists and violinists: a pilot study. *Medical Problems of Performing Artists* June 2001: 58-65.

Willingham DB (1999): The neural basis of motor-skill learning. *Current Directions in Psychological Science* 8(6): 178-182.

Willingham DB, Goedert-Eschmann K (1999): The relationship between implicit and explicit learning: evidence for parallel development. *Psychological Science* 10: 531-534.

Zaza C (1994): Research-based prevention for musicians. *Medical Problems of Performing Artists* March 1994: 3-6.

Zaza C (1998): Playing-related musculoskeletal disorders in musicians: a systematic review of incidence and prevalence. *Canadian Medical Association Journal* 158 (8):1019-1025.

Zaza C, Charles C, Muszynski A (1998): The meaning of playing related musculoskeletal disorders to classical musicians. *Social Science and Medicine* 1998 (12): 2013-2023.

Zaza C, Farewell VT (1997): Musicians' playing related musculoskeletal disorders: an examination of risk factors. *American Journal of Industrial Medicine* 32: 292-200.

Zetterberg C, Backlund H, Karlsson J, Werner H, Olsson L (1998): Musculoskeletal problems among male and female music students. *Medical Problems of Performing Artists* December 1998: 3-6.

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INFORMATION FOR PARTICIPANTS

This study is called:

"Musicians' Injuries Prevention and Management Survey"

You have been asked to participate in this study because you are a professional musician and we are aiming to look at the types of strategies commonly used by professional musicians in the prevention and management of work-related overuse injuries.

Participation in this study is entirely voluntary. You may withdraw at any time without affecting your relationship with the researchers or the institutions.

If you agree to take part in this study you will be required to fill out a questionnaire regarding occupationally related pain or dysfunction which should take no longer than ten minutes.

All replies are anonymous and will be treated confidentially.

If you have any questions about the project please do not hesitate to contact Roger Adams at the office on (02) 9351 9275. If I am not there please leave a message and I will phone you back as soon as possible.

If you have a concern or complaint about the project please contact me to discuss the matter, or you can contact the Manager of Ethics and Biosafety Administration , University of Sydney, on (02) 9351 4811.

Thank you for considering this project.

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Faculty of Health Sciences

INFORMED CONSENT

I, _____ hereby voluntarily consent to participate in the research entitled:

_____

_____

conducted by: _____

I understand that the information obtained from this research may be used in future research, and may be published. However, my right to privacy will be retained, i.e: personal details will not be revealed.

The procedure as set out in the attached information sheet has been explained to me and I understand what is expected of me and the benefits and risks involved. My participation in the project is voluntary.

I acknowledge I have the right to question any part of the procedure and can withdraw at any time without this being held against me.

I have been familiarised with the procedure.

Signed by Subject _____

Date: _____

Witness _____(Name)

_____(Signature)

_____(Date)

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MUSICIANS' INJURIES PREVENTION

AND

MANAGEMENT SURVEY

Research indicates that a very high percentage of professional musicians experience work related pain/injury and that some are forced to take significant periods of leave in order to reduce symptoms.

As musicians who continue to survive in a highly competitive and demanding profession, we would like to ask you about the strategies you use to **prevent** and/or **manage** your work related overuse injuries.

Musicians as a profession will benefit from the collating of this information. We would be happy to provide you with a summary of the results.

This questionnaire should take about 10 minutes of your time.

All replies are anonymous and will be treated confidentially. Summary information only will be available from this survey.

Thank you for taking the time to participate in this survey.

SECTION ONE - BACKGROUND INFORMATION

Instrument played

1. Please mark the instrument you primarily play with "1", and any other instrument you regularly play at a professional level with "2".

☐ Violin
☐ Viola
☐ Cello
☐ Double Bass
☐ Harp
☐ Flute
☐ Piccolo
☐ Clarinet
☐ Bassoon
☐ Oboe
☐ Horn
☐ Trumpet
☐ Trombone
☐ Tuba
☐ Percussion
☐ Keyboard
☐ Other (please specify) _____ _____

2. Number of years you have been playing your primary instrument

☐☐

3. Your age in years

☐☐

Average number of hours played per day

4. What is your estimate, over the previous three (3) working days, of the number of hours you have played per day, including practice, rehearsal and all performances? Please circle:

Day 1	1	2	3	4	5	6	7	8	9	10	11	12
Day 2	1	2	3	4	5	6	7	8	9	10	11	12
Day 3	1	2	3	4	5	6	7	8	9	10	11	12

5. How typical would the above number of hours be compared with your usual workload?

Please tick:

☐ much more ☐ more ☐ typical ☐ less ☐ much less

Activities during time away from your instrument

For the purpose of this study "a working week" refers to a seven day period during which you are not on leave or vacation.

6. How regularly do you have instrument-free days during each working week?
Please tick:

☐ never ☐ occasionally ☐ usually ☐ almost always ☐ always

7. In a typical working week how many instrument-free days do you try to have?
Please circle:
0 1 2 3 4 5 6 7

8. Do you participate in activities, other than playing your instrument, which involve prolonged use of, or place a heavy load on the arms and hands? Please tick any which apply:

☐ no
☐ using a computer
☐ painting/drawing
☐ pottery
☐ gardening
☐ fishing
☐ house renovation
☐ house painting
☐ knitting
☐ handicrafts
☐ other (please describe briefly) _____

SECTION TWO – WORK RELATED PAIN AND DYSFUNCTION

9. Have you ever experienced work related pain/injury? Please tick:

☐ Yes

☐ No

If you answered no, please go to question 16

10. If you experience playing related pain, do you react:
Please tick:

☐ not at all

☐ immediately

☐ if pain persists for more than one day

☐ if pain persists for up to a week

☐ if pain persists for more than a week

11. When you have experienced work related pain/injury did you find it necessary to:
(Tick any of the below which apply to you)

	Yes	No
Take time off work	☐	☐
Modify your playing style	☐	☐
Modify your practice routine	☐	☐
Refuse additional work	☐	☐

12. If it was necessary for you to take time off work did this occur:
(Please tick)

- ☐ on one occasion only
- ☐ on more than one occasion

13. If it was necessary for you to take time off work **on one occasion only**, was your period of absence:
(Please tick)

- ☐ less than 5 working days
- ☐ 1-2 weeks
- ☐ 2-4 weeks
- ☐ 1-3 months
- ☐ 4-6 months
- ☐ more than 26 weeks

14. Did you take time off work:
(Please tick)

- ☐ on one occasion
- ☐ on two occasions
- ☐ on three occasions
- ☐ on four occasions
- ☐ on five or more occasions

15. If it was necessary for you to take time off work **on more than one occasion** was the average amount of time **per episode**:
Please tick:

- ☐ less than 5 working days
- ☐ 1-2 weeks
- ☐ 2-4 weeks
- ☐ 1-3 months
- ☐ 4-6 months
- ☐ more than 26 weeks

16. After a period of absence, eg holidays do you:
Please tick:

- ☐ Return to usual playing levels of practice, rehearsal and performance immediately
- ☐ Gradually increase practice sessions
- ☐ Gradually increase rehearsals
- ☐ Gradually increase performances

17. In your opinion, is there any relation between your repertoire and your pain levels?
Please tick:

☐	☐	☐	☐	☐
not all	slight degree	moderate degree	large degree	totally

18. To what extent can you control the repertoire you play?
Please tick:

☐	☐	☐	☐	☐
totally	to a large degree	to a moderate degree	to a slight degree	not at all

19. How often do you take regular breaks during practice sessions?
Please tick:

☐ every 15 minutes

☐ every 30 minutes

☐ every hour

☐ after more than an hour

☐ not at all

20. To what extent do you use mental practice, ie mentally rehearsing a phrase or passage? Please tick:

☐	☐	☐	☐	☐
never	sometimes	frequently	most of the time	all the time

SECTION THREE - STRATEGIES

21. Please circle the following to indicate **your view** as to how useful these strategies are in preventing overuse injuries from occurring or becoming aggravated.

MODIFICATION OF PRACTICE/PERFORMANCE ROUTINE	Not tried (Circle)	Tried (Circle) Not useful						Very useful
Limiting practice time	0	1	2	3	4	5	6	7
Changing practice routines	0	1	2	3	4	5	6	7
Sitting versus standing for practice	0	1	2	3	4	5	6	7
Regular rest breaks	0	1	2	3	4	5	6	7
Selection of music	0	1	2	3	4	5	6	7
Active relaxation during playing	0	1	2	3	4	5	6	7

PHYSICAL SUPPORT	Not tried (Circle)	Tried (Circle) Not useful						Very useful
Use of chin rest	0	1	2	3	4	5	6	7
Use of shoulder rest	0	1	2	3	4	5	6	7
Other supports,eg straps or stands	0	1	2	3	4	5	6	7

SELF MANAGEMENT STRATEGIES	Not tried (Circle)	Tried (Circle) Not useful						Very useful
Relaxation	0	1	2	3	4	5	6	7
Meditation	0	1	2	3	4	5	6	7
Gym programme	0	1	2	3	4	5	6	7
Exercise programme	0	1	2	3	4	5	6	7
Yoga	0	1	2	3	4	5	6	7
Swimming	0	1	2	3	4	5	6	7
Walking	0	1	2	3	4	5	6	7
Golf	0	1	2	3	4	5	6	7

TREATMENT MODALITIES	Not tried (Circle)	Tried (Circle) Not useful						Very useful
Alexander technique	0	1	2	3	4	5	6	7
Feldenkrais technique	0	1	2	3	4	5	6	7
Physiotherapy	0	1	2	3	4	5	6	7
Chiropractic	0	1	2	3	4	5	6	7
Osteopathy	0	1	2	3	4	5	6	7
Naturopathy	0	1	2	3	4	5	6	7
Other Please specify	0	1	2	3	4	5	6	7

MEDICATION	Not tried (Circle)	Tried (Circle) Not useful						Very useful
Painkillers	0	1	2	3	4	5	6	7
Beta blockers	0	1	2	3	4	5	6	7
Anti-inflammatory medication	0	1	2	3	4	5	6	7
Stress reducing medication Eg Prozac	0	1	2	3	4	5	6	7
Other Please specify	0	1	2	3	4	5	6	7

HEALTH/LIFESTYLE	Not tried (Circle)	Tried (Circle) Not useful						Very useful
Diet	0	1	2	3	4	5	6	7
Limiting caffeine intake	0	1	2	3	4	5	6	7
Reducing/stopping smoking	0	1	2	3	4	5	6	7

22. Do you use the strategies you have found effective for preventing or reducing pain: Please tick:

☐ All the time

☐ Only if you have pain or disruption to playing

23. Did you receive information about prevention of injuries during your training, eg during individual lessons, or as part of a formal course such as tertiary education? Please tick:

☐ Yes from individual teacher

☐ Yes from fellow musicians

☐ Yes at university, as part of course work, or workshop

☐ Yes from health professional, eg physiotherapist, Feldenkrais practitioner

☐ No never received any information, worked out strategies for myself

24. In your opinion, what could be included in the training for the instrument you play which might help prevent disruptions to performance or practice later in one's career?

25.What would be the single most important piece of advice you would give to a young musician starting his or her career about the prevention or management of overuse injuries?

APPENDIX III

Musicians' Interview (Semistructured format)

I would like to ask your opinion about the different factors which might lead to playing related injuries, and how injuries might be prevented or managed.

1) What is your instrument?

2) How many years have you been a professional musician?

3) How many years have you been playing for altogether?

4) Could you give me some idea of your workload/career over the last 5 years?

5) Is it possible to achieve high professional levels pain free?

   Note: interpretation of question; as a process on the way to achieving professional levels, and maintaining once those levels have been achieved

6) What factors do you think lead to playing injuries?

7) (ask for further details if necessary eg factors out of the musicians control, such as the environment, industrial issues – have these improved at all in the last 10 years for example)

8) Do you think injuries can result from high aspirations?

9) In your experience how severe does an injury have to be before a musician would seek help?

10) Is it possible for a musician to continue a professional career while compensating for injury?

11) In your opinion can playing related injuries be prevented?

12) (ask for further details if necessary)

13) How useful are external supports such as chin rests in helping prevent injury?

14) Is there any stigma attached to using other external supports?

15) As a student were you taught about injury prevention?

16) (ask further details if not elaborated in Q 15)

17) Were there any particular musicians who played the same instrument as you who influenced you as a student?
(Look for technical influences, such as the way the instrument is held)

18) (ask further details about why and how, if not elaborated in Q 17)

19) From your experience is it possible to predict which students are likely to have injuries later on?

20) (ask further details if necessary)

21) What do you teach your students about preventing injury?

22) Have you found any particular system of movement awareness, such as Feldenkrais,Alexander technique to be beneficial in preventing or managing playing related injuries?