University of Bath

UNIVERSITY OF BATH

PHD

The effects of mental workload on medicines safety in a community pharmacy setting

Family, Hannah

Award date:
2013

Awarding institution:
University of Bath

Link to publication

The effects of mental workload on medicines safety in a community pharmacy setting

Hannah Elizabeth Family

A thesis submitted for the degree of Doctor of Philosophy

University of Bath

Department of Pharmacy and Pharmacology

June 2013

Abstract

Background: Concern has been raised that the workload of community pharmacists (CPs) is linked to the occurrence of dispensing errors (DEs). One aspect of workload that has not yet been measured in this setting, but has been linked to errors in other industries, is mental workload (MWL).

Aims: (1) Measure the relationship between MWL and DEs during a routine pharmacy task, the final accuracy check, which research suggests is critical to DE prevention. (2) Quantify the role that expertise plays in this relationship. (3) Explore CPs and pharmacy students' experiences of MWL and DEs.

Methods: A mixed methods approach was taken and three studies were conducted. In study one, CPs (n=104) and students (n=93) checked dispensed items for DEs. Participants took part in one of four conditions (distraction, no distraction, dual-task or single-task) and their DE detection and MWL was measured. Study two was a diary study of CPs' (n=40) MWL during a day in their "real-life" practice. Study three presented an interpretative phenomenological analysis of CPs' (n=14) and students' (n=15) experiences of MWL and DEs.

Main findings: Study one found that high MWL was related to reduced DE detection, but only for students, confirming the important role of expertise. Distractions did not affect DE detection but was linked to increased MWL. Study 2 highlighted specific times of the day when CPs' MWL was exceptionally high. Study 3 found several factors which increased MWL, including the lack of control CP's had over their workload, difficulties communicating with prescribers and targets.

Conclusions: MWL has been found to be a useful tool for measuring the impact of workload on pharmacy safety. The findings are linked to current work design and human factors theory and suggestions are made for how CPs' work could be redesigned to reduce their MWL and improve safety.

Acknowledgements

This thesis is the culmination of three years of work which couldn't have happened without the support of many people.

My thanks go to the University of Bath for my research studentship which funded the student pharmacist research in this thesis. I am also very grateful to Pharmacy Research UK who provided funding to allow me to expand my research to community pharmacists. Being able to work with community pharmacists added a great deal of rigour to this research and without this funding this would not have been possible. My thanks also to the project management group who gave their time to guide and advise the community pharmacist study.

Thank you to all the community pharmacists and pharmacy students who took part in this research. Thank you for your time, patience and interest.

A big thank you to Mr Chris Coy who dispensed and re-dispensed many items for the accuracy checking studies. Thanks also to Dr Lynette James for all her support with my research and for kindly sharing many insights into the dispensing error research field. Thank you also to the team in reception, and Laura and Amanda who helped me transcribe the interviews.

I have had the great fortune to work in a department filled with enthusiastic and talented PhD students and Research Officers, who have inspired me, made my PhD so much more enjoyable, and have become great friends. Thank you also to all the academics and teacher practitioners in the pharmacy practice group who I have had the pleasure of working with on other projects, in particular Dr Denise Taylor, Dr Jenny Scott, Dr Anita McGrogan and Dr Andrea Taylor. I have greatly valued your friendship, support and encouragement during this process.

Thank you to my car-share ladies, and friends outside of the university who have regularly been subjected to detailed research and thesis updates. You are true friends for listening to these updates so patiently!

Thank you to my two supervisors, Dr Jane Sutton and Professor Marjorie Weiss. Marjorie, I will always be thankful that you persuaded me not to do the 5 other studies I had planned for this PhD. In hindsight, that may have been just a little too

enthusiastic! Jane, you could not have made this PhD experience more enjoyable. Thank you for putting up with my Hannah moments, for encouraging me to be as creative as I wanted with my PhD and for being the best mentor a PhD student could hope for. You are a great friend and I look forward to our research collaborations in the future.

My final and biggest thank you goes to my family. This thesis (and my other degrees) would not have been possible without the support (both practical and emotional) you all gave me. To my parents (whose experiences of working as healthcare professionals in the NHS in part inspired this PhD) thank you for your constant encouragement and belief that I was able to do this (and for the meals and ironing that you did when I was writing up / Oli was away)! To my sister Libby (a.k.a Chartered Accountant Extraordinaire), thank you for always being at the other end of a phone and encouraging me when I needed it, even though during this time you have also been revising for your many, many exams! I look forward to spending more time hanging out together now we both have our weekends back.

Above all I would like to thank my husband Oli, who lived this experience as much as I did. You picked up the slack at home, and put up with many late nights, early mornings and weekends filled with thesis drafting. One of the many things I love about you is your passion and skill in your work and for your field and this has always been a great source of inspiration and motivation for me to achieve the same in my own work.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

ACT(s)	Accredited checking technician(s)
CLT	Cognitive Load Theory
CP(s)	Community pharmacist(s)
CSM	Cognitive Systems Model
DE(s)	Dispensing error(s)
DSSQ	Dundee Stress State Questionnaire
EPS	Electronic Prescription Service
GB	Great Britain
GP(s)	General Practitioner(s)
GPhC	General Pharmaceutical Council
GSR	Galvanic skin response
IPA	Interpretative Phenomenological Analysis
ISO	International Organisation for Standardisation
JCM	Job Characteristics Model
LTM	Long-term memory
MPharm	Master of Pharmacy
MRT	Multiple Resource Theory
MUR(s)	Medicine use review(s)
MWL	Mental workload
NASA-TLX	National Aeronautics and Space Administration – Task Load Index
NPSA	National Patient Safety Agency
PCS	Prescription collection service
REACH	Department for Health Research Ethics Approval Committee for Health
RPharmS	The Royal Pharmaceutical Society
SA	Situation awareness
SOP(s)	Standard operating procedures
STM	Short-term memory
TA	Think Aloud
UK	United Kingdom
USA	United States of America
WL	Workload
WM	Working Memory

Glossary of Terms

Accredited checking technician(s) (ACT(s))

An ACT is a pharmacy technician who has undergone further training in order to practice as an ACT. This training enables them to carry out the final accuracy checks of medicines dispensed by a pharmacist or another member of the pharmacy team (NHS Careers, 2013).

Clinical Commissioning Groups (CCGs)

Clinical commissioning groups commission most services in their local area on behalf of patients, including: emergency care, hospital care, mental health and learning disability services. CCGs were established in April 2013 (NHS Choices, 2013).

Cognitive Load Theory (CLT)

A theory which is concerned with how individuals learn new tasks, particularly complex tasks, which requires learners' full cognitive capacity. This theory differentiates between the different types of load that can be placed on a learner's cognitive processes and how this can be managed in order to improve the learners' assimilation of knowledge and skills (Paas, Tuovinen, Tabbers, & Van Gerven, 2003).

Community pharmacist(s) (CP(s))

Community pharmacists usually work in high street, local, or rural pharmacies. Community pharmacists ensure the safe supply of prescribed and over the counter medicines, and provide advice about, medicines and how to take them, symptoms and general health matters.

Cognitive Systems Model (CSM)

A model of the factors which affect human cognitive processing in the workplace. This model was proposed by psychologist Professor Anthony Grasha and his colleagues to test predictions about the factors which may affect pharmacists' performance in the workplace. This model depicts how characteristics of the individual, the organisation, the environment, interpersonal interactions, and extra-organisational influences may affect an individual's emotional reaction to their work, the functioning of their cognitive processes and as a consequence their performance on task (Grasha, 2001b).

Dispensing error(s) (DE(s))

A dispensing error is an error made in the preparation of a prescribed medicine for a patient. This can include errors on the pharmacy label (e.g. an error in the directions on how to use the medicine) or an error with the medicine (e.g. the wrong medicine has been dispensed). A dispensing error is formally defined in the research literature as "any unintended deviation from professional or regulatory references, or guidelines affecting dispensing procedures, is also considered a dispensing error" (Franklin & O'Grady, 2007, p. 275).

D-prime (d')

A measure of signal detection theory (see below). D-prime is an index which can be calculated to represent the sensitivity of an observer (human or machine) to a signal. People may vary in their sensitivity to a signal, and individuals' sensitivity to a signal may vary over time (e.g. due to fatigue).

Dundee Stress State Questionnaire (DSSQ)

A battery of five questionnaires designed to measure mood, motivation and cognition in work performance settings.

Electronic Prescription Service (EPS)

EPS enables prescribers (e.g. GPs and practice nurses) to send prescriptions electronically to a pharmacy of a patient's choice. Many pharmacy and GP services now offer an EPS service, and it can make the prescribing and dispensing process more efficient and convenient (HSIC, 2013).

Epistemology

A branch of philosophy concerned with the study of knowledge.

False Alarms

This is the term used in signal detection theory (see below) to describe an event when an observer (human or machine) incorrectly identifies noise as a signal (see also hits, correct rejections and misses).

General Practitioner(s) (GP(s))

General practitioners are doctors who work in primary care and are part of the clinical commissioning group. GPs provide care within the local community and are patients' first port of call for acute and chronic illness. GPs also provide preventative care and health education to patients (Medical Careers, 2013).

General Pharmaceutical Council (GPhC)

The GPhC is the independent regulator of pharmacists, pharmacy technicians and pharmacy premises in Great Britain. They approve qualifications for pharmacists and pharmacy technicians, and accredit training providers. They maintain a register of pharmacists, technicians and premises. They set codes of practice, standards, and continuing professional

development requirements for the profession as well as monitoring pharmacist and pharmacy technicians' fitness to practice which includes dealing with complaints and concerns from the public and pharmacy teams (General Pharmaceutical Council, 2013).

Galvanic skin response (GSR)

Measured with a galvanometer, the GSR is a change in the electrical resistance of the skin, this resistance changes as an autonomic response in line with mood states, and often is used as a measure of psychological stress.

Hits

This is the term used in signal detection theory (see below) to describe the event when an operator (human or machine) correctly identifies a signal as a signal (see also false alarms, correct rejections and misses).

Independent pharmacy

A community pharmacy (or a chain of up to six pharmacies) owned by an individual pharmacist or group of pharmacists.

Interpretative Phenomenological Analysis (IPA)

An approach to qualitative research with an ideographic focus (a focus on the individual experience rather than a collective experience of a number of people), that aims to generate insights into how individuals make sense of their personal and social world and the meanings people attribute to states, events experiences.

International Organisation for Standardisation (ISO)

The world's largest developer of voluntary international standards which outline state of the art specifications for products, good practice and services. These standards are specified with the intention of making industries more efficient and effective (ISO, 2013).

Master of Pharmacy (MPharm)

The four year university degree programme, which since 2001 has been the required qualification for admission into a pre-registration pharmacist post in the UK. To become a fully qualified pharmacist, an individual must study and pass the MPharm programme, be accepted onto and complete a one year pre-registration post and at the end of that pass a series of professional exams set and administered by the GPhC.

Medicine use review(s) (MUR(s))

Is one of the advanced pharmacy services offered by UK pharmacies who have a pharmacist accredited to provide them. It is a free service aimed at patients taking multiple medicines, in particular individuals who also have long-term conditions. The aim of carrying out an MUR is to ensure that the patient is able to take these medicines as agreed with their prescriber, that

there are no side effects or interactions being caused by the multiple medicines prescribed and where issues are experienced by patients (e.g. no benefit from the medicine, or several side effects) to make recommendations using their expert knowledge in medicines use, which are then communicated to the patient and sent to the prescriber (Pharmaceutical Services Negotiating Committee, 2013b).

Mental workload (MWL)

Is a term describing an individual's subjective experience of their work and workload. It is further defined as the product of the interplay between the demands of a task, the expertise and ability of the individual in the task, and the motivational and environmental context in which the task is performed (Hockey, 2002; Wickens, 1992).

Misses

This is the term used in signal detection theory (see below) to describe the event when an operator (human or machine) fails to identify a signal and instead classes it as noise (see also false alarms, correct rejections and hits).

Multiple Pharmacy

Community pharmacy premises owned by large organisations (e.g. Boots, Lloyds) are described as 'multiples' or national pharmacy chains.

National Aeronautics and Space Administration – Task Load Index (NASA-TLX)

This is a six item questionnaire developed by the National Aeronautics and Space Administration to measure mental workload.

National Patient Safety Agency (NPSA)

This agency closed in June 2012, prior to its closure the NPSA monitored the safety of healthcare and this included requesting data from pharmacies and primary care trusts on medicine errors and dispensing errors. The NPSA also provided guidelines and information on enhancing patient safety within services including in the dispensing and labelling of medicines.

Pharmacy Technician

Pharmacy technicians label and dispense medicines, provide information to patients about their medicines, how to use medicines, and give advice about the management of minor ailments and over the counter medicines. Since July 2011 pharmacy technicians have been regulated by the General Pharmaceutical Council, and since this time new pharmacy technicians must complete GPhC approved qualifications in order to practice and register as a pharmacy technician (NHS Careers, 2013).

Positivist enquiry

A philosophical standpoint in research, taken by quantitative researchers, based on the assumption that we exist in a stable reality and therefore there is a potential right explanation for every phenomenon (Breakwell, Hammond, Fife-Schaw & Smith, 2006; J. Green & Thorogood, 2004).

Prescription collection service (PCS)

This is a service offered by many pharmacies who will collect repeat prescriptions on behalf of their patients (if they request this service) from their GP and take them back to the pharmacy for these prescriptions to be dispensed. The patient has to phone their GP to order the repeat prescription and then phone and let their pharmacist know to pick it up, but this means that they only have to visit their pharmacist to pick up their medicine when it is ready, instead of also making a trip to the GP to collect their prescription.

Response criterion

A measure of signal detection theory (see below). The response criterion indexes an observer's (human or machine) response bias, for example an observer may show a "liberal" response criterion or in other words more prone to saying "yes there is a signal" compared to the "standard" or "perfect" observer. If the observer shows a liberal response criterion they are likely to make more false alarms (see above), which in some settings, like healthcare, can be costly in time and effort.

Responsible Pharmacist

In order to lawfully run a community pharmacy business, a registered pharmacist must be in charge of the registered pharmacy premises, as the responsible pharmacist. Where there is more than one pharmacist working in the pharmacy, one of these pharmacist will take on the role of responsible pharmacist. The responsible pharmacist ensures the safe and effective running of the pharmacy business (RPS Support, 2011).

Signal Detection Theory

Signal detection theory (SDT) is applied to situations where there are two distinct states (e.g. signal and noise) and a human operator, a machine, or both, is attempting to distinguish between this signal and noise, and say "yes I have identified a signal" (in the context of this study a signal would be a dispensing error amongst the noise of correctly dispensed items) or "no I have not detected a signal." This theory proposes there are two stages to human (or machine) information processing, 1) information is collected about the presence or absence of a signal, 2) the person (or machine) then decides whether this information came from a signal or not (Wickens, et al., 2013).

Situation awareness (SA)

A theory which describes the level of peoples' perception of what is happening around them and in their environment at any one moment in

time and prediction of what might happen in the immediate future (Endsley, 1995). At the most basic level, people aim to be situationally aware when they are driving or crossing the road as they are monitoring the actions of others and the environment around them before making a decision to turn into a new street or cross the road.

Small and medium chain pharmacies

A chain of community pharmacies which has more than six stores, but their stores are not located across the nation. The largest medium chain pharmacy in the UK is currently Day Lewis Pharmacy which has over 200 pharmacies mainly located in the South of England.

Standard operating procedures (SOP(s))

A prescribed procedure developed by a pharmacy or pharmacy organisation for how key tasks in the pharmacy are to be undertaken.

The Royal Pharmaceutical Society (RPharmS)

This is the professional body for pharmacists and pharmacy in England, Scotland and Wales.

Working Memory (WM)

A model of short-term memory proposed by Baddeley and Hitch (1974) which is attention demanding and functions to remember new information (e.g. a telephone number until we write it down, or dial it). This model also proposes that short-term memory processes are used as a conscious workspace where new information can be combined with old information, evaluated built upon, or transformed. Working memory also holds new information until it can be encoded in long-term memory (Wickens, et al., 2013).

CHAPTER 1:

INTRODUCTION

"*Absolutely and I think our role should be publicised a lot more but then the support has got to be there as well because you know things have changed phenomenally in the pharmacy over the last 10 years and we are doing a lot more than we have ever done before, certainly when I qualified the thought of actually injecting anyone in the pharmacy was completely alien, and now it is something we do sort of year in year out*"

Community Pharmacist 3

The role of community pharmacists (CPs) working in Great Britain (GB) has undergone major reform over the last twenty to thirty years. The greatest changes have been seen in the last eight years with the introduction, between 2005 and 2006, of new contractual frameworks for community pharmacies in GB. The introduction of the new contractual frameworks has reportedly caused a large increase in the amount of work that community pharmacy teams are undertaking (Gidman, 2011). The reported increase in workload (WL) has been coupled with reports of increased stress and decreased job satisfaction among CPs (Gidman, 2011), intentions to leave (including those recently qualified) (Eden, Schafheutle, & Hassell, 2009) and growing concerns that increases in WL may reduce patient safety (Hassell, Seston, Schafheutle, Wagner, & Eden, 2011). These concerns are also not limited to community pharmacy in GB, similar reports have been made in the United States of America (USA) and Canada (Grasha, 2001a). A review of the dispensing error (DE) literature found that WL was the most frequently reported contributor to DEs in hospital and community pharmacies (James, Barlow, McArtney, Hiom, Roberts, & Whittlesea, 2009). Pharmacist WL and working hours have also been implicated in high profile cases where pharmacists have made or missed DEs (e.g. Anon, 2009). However, there is as yet no firm evidence to directly link DEs occurring in community pharmacies with the WL pressures experienced by CPs (Grasha, 2001a; RPS & PPRT, 2009). If WL is related to DEs then this presents a growing patient safety issue.

1.1. Community pharmacist workload

On their introduction, the new frameworks placed a greater emphasis on the provision of new professional clinical services by CPs (e.g. medicine use reviews, smoking cessation service). This emphasis came about as a result of reductions in the level of reimbursement CPs received for their traditional dispensing activities, and increased funding being made available for the new clinical services (Hassell, et al., 2011). The majority of CPs were in favour of the planned introduction of the 2005 contractual framework (Baumber, 2004). In the new frameworks CPs saw the potential to raise the profile of community pharmacy practice and provide new

opportunities for the profession beyond the core business of dispensing of medicines. However, annual figures of the numbers of community pharmacy services undertaken concur with reports that the WL of CPs has dramatically increased since the 2005 contractual framework came into effect (Prescribing and Primary Care team, 2012). For example, between 1st April 2005 and 31st March 2012 there was a 22% increase in the number of items dispensed, a 335% increase in medicine use reviews (MURs), and a 73% increase in the provision of local enhanced services in English community pharmacies (Prescribing and Primary Care team, 2012). Between 2005 and 2011 there was a 23% increase in the number of pharmacists registered as practising in England (Hassell, 2012; Hassell & Eden, 2006; Seston & Hassell, 2011). However, this figure accounts for numbers of both CPs and hospital pharmacists, indicating that community pharmacy staffing levels are not increasing in-line with the volume of work. It is unclear whether pharmacy technician numbers have increased to help manage the WL as they have only been required to be registered with the regulatory body, the General Pharmaceutical Society (GPhC), who provide the pharmacy workforce data, since July 2011 (Seston & Hassell, 2012). These figures suggest that CPs are now managing a much greater WL, and evidence from qualitative studies with CPs is that they perceive that their WL has increased to a level which reduces patient safety (Gidman, 2011; Gidman, Hassell, Day, & Payne, 2007). However, research and evaluations of pharmacy WL to date have been unable to directly assess the relationship between CP WL and DEs. This is because research in this area has mainly involved survey data, self-report measures of DEs and observational field studies. These approaches lack the required control over confounding variables and timely measurement of DEs and WL in order to directly assess whether it is WL that causes DEs. Before considering whether WL may impact on the occurrence of DEs in a community pharmacy setting, it is important to consider the dispensing process undertaken by CPs and their teams and the stages which may be susceptible to WL pressures.

1.2. The dispensing process

In 2011-12 1.044 billion prescription items were dispensed by community pharmacies in England, Scotland and Wales (Information Services Division Scotland, 2012; Prescribing and Primary Care team, 2012; Thomas, 2012). As can be seen from Figure 1.1 below there are up to 14 discrete stages involved in the dispensing of a prescription item (James, et al., 2009; NPSA, 2007b). These processes include but are not limited to safety checks, selection of the medicine and label generation (with directions on how to use the medicine and the patient's details). It could be argued that a number of stages of this process do not need to be completed by a CP. Depending on the size and staffing level of the community pharmacy, the CP may carry this process out in its entirety, or a team of pharmacy staff including the CP and pharmacy technicians (dispensing technician or accredited checking technician (ACT)) may be involved in this process. The key stage carried out by CPs is a clinical and legal check of the prescription to ensure that the medicine is prescribed correctly and is safe and appropriate for the patient to take. At this stage the CP will also ensure that all the legal aspects of the prescription have been completed (e.g. signed by prescriber) (RPS Support, 2011). The dispensing process may not always occur in the order shown in Figure 1.1, for example the clinical, legal and accuracy check may all be carried out at the end (all at the same time) by a CP. A review of CPs WL by Hassell et al (2011) found that CPs spent between 28-75% of their time involved in dispensing activities. This suggests that despite support from other members of the pharmacy team, and the additional WL of enhanced and advanced services, CPs are still greatly involved in the dispensing process.

```
┌─────────────┐   ┌─────────────┐   ┌─────────────┐
│ Receipt of  │   │ Medication  │━━━│  Product    │
│prescription │   │  assembly   │   │ Labelling   │
└─────────────┘   └─────────────┘   └─────────────┘
      ┃                 ┃                 ┃
┌─────────────┐   ┌─────────────┐   ┌─────────────┐
│ Validation  │   │    Stock    │   │ Completion  │
│ of patient  │   │  selection  │   │of registers │
│ information │   │             │   │             │
└─────────────┘   └─────────────┘   └─────────────┘
      ┃                 ┃                 ┃
┌─────────────┐   ┌─────────────┐   ┌─────────────┐   ┌─────────────┐
│   Log of    │   │   Label     │   │   Self-     │   │   Patient   │
│prescription │   │ generation  │   │ checking/   │   │ counselling │
│             │   │             │   │  endorsing  │   │             │
└─────────────┘   └─────────────┘   └─────────────┘   └─────────────┘
      ┃                 ┃                 ┃                 ┃
┌─────────────┐   ┌─────────────┐   ┌─────────────┐   ┌─────────────┐
│   Legal/    │   │             │   │   Final     │   │  Issue of   │
│  technical  │━━━│  Clinical   │   │  accuracy   │━━━│ medication  │
│   check     │   │   check     │   │   check     │   │             │
└─────────────┘   └─────────────┘   └─────────────┘   └─────────────┘
```
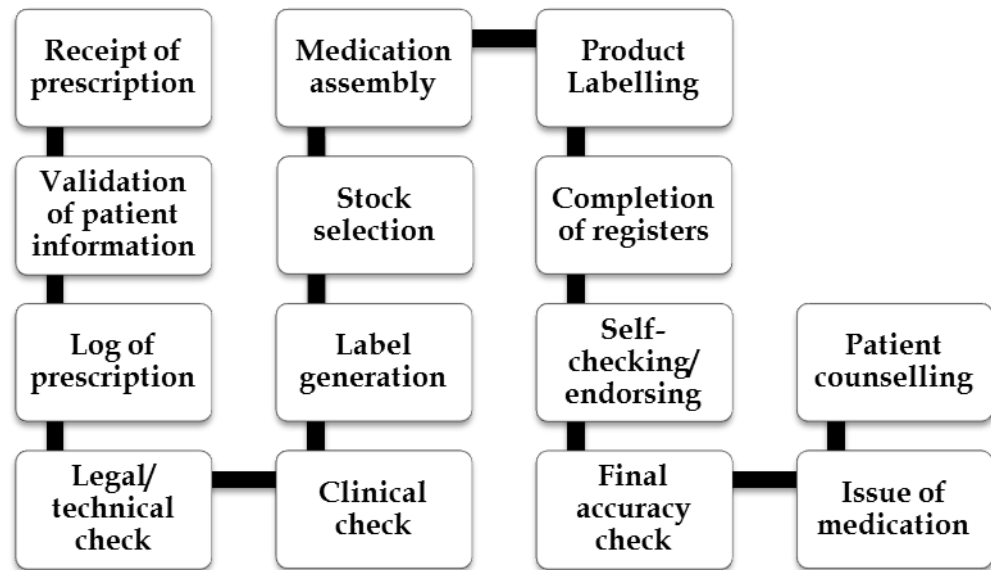
Figure 1.1: *The dispensing process* (from James, et al., 2009, p.10, with permission)

1.3. Community pharmacy dispensing errors

Research has shown that DEs may occur at any stage of the dispensing process (Ashcroft, Quinlan, & Blenkinsopp, 2005). However before exploring how and why DEs occur and if CP WL is related to DEs, what constitutes a DE is defined. There are numerous definitions available in the literature outlining what constitutes a DE (James, et al., 2009). However, the most widely cited and accepted definition of a DE is *"any unintended deviation from an interpretable written prescription or medication order. Both content and labelling errors are included. Any unintended deviation from professional or regulatory references, or guidelines affecting dispensing procedures, is also considered a dispensing error"* (Franklin & O'Grady, 2007, p. 275). There are also many terms used to identify different types of DEs. For example, an error that occurs during the dispensing process but is detected before the medicine is given to the patient has been described as a near miss, process error or prevented DE (Grasha, Reilley, Schell, & Tranum, 2001; James, et al., 2009; NPSA, 2007b). DEs that are not identified before the medicine is given to the patient have been termed as missed errors, unprevented DEs and external errors (James, et al., 2009; NPSA, 2011). For the purposes of this study the terms prevented and unprevented DEs will

be used, as these have been the common terms used to describe different types of DEs by the National Patient Safety Agency (NPSA, 2007b).

Current knowledge on the incidence of DEs in community pharmacies in GB has mainly been based on observational and self-report studies. The findings suggest that prevented DEs occur at a rate of 0.002 to 0.48% (Ashcroft, et al., 2005; Chua et al., 2003). Unprevented DEs are estimated to occur at a rate ranging from 0.0004 to 3% (Ashcroft, Morecroft, Parker, & Noyce, 2006; Chua, et al., 2003; Franklin & O'Grady, 2007). There is some mismatch in these findings, as a 3% unprevented DE rate seems high compared to the other estimates, especially as that would suggest a much higher prevented DE rate. However, the research into prevented DEs has been conducted through self-report studies. Therefore it could be proposed that Franklin & O'Grady's (2007) observational study, which found the 3% unprevented DE rate, is more representative of the actual error rate. This is because if a pharmacist fails to detect that an error has been made, unless they are made aware of this error when a patient or carer spots it, the error will not be captured by the self-report studies, as the pharmacist is not aware there is anything to report. The observational study may also underestimate these events as it could not eliminate the bias caused by the Hawthorne effect [1] (James, et al., 2009). In other words, when being observed pharmacists may have been more vigilant than they would have been if they were unobserved. In further analyses of their self-report data Ashcroft et al (2005) found that whilst errors had reportedly occurred at all stages in the process, up to 60% of all DEs occurred at the point when the product to be dispensed was selected from the pharmacy stock (e.g. where two or more products have similar packaging). They also found that the majority of DEs were identified when the product was labelled or when another member of staff carried out a final accuracy check of the dispensed

---

[1] The methodological Hawthorne effect, is defined as the problem in field experiments that participants' knowledge that they are in an experiment, or that they are being observed modifies their behaviour from what it would have been without the knowledge. This term was coined by Henry Landsberger in 1950 following a reanalysis of a set of studies conducted between 1924-32 on the performance of employees at the Hawthorne Works of Western Electric in Chicago (Adair, 1984).

item. In the future the final accuracy check is likely to become more important in the detection of DEs if automated dispensing systems are rolled out in UK community pharmacies. This is because research has shown that these systems reduce, but do not completely eradicate product selection errors, or indeed other errors that occur during the dispensing process (Franklin & O'Grady, 2007; Franklin, O'Grady, Voncina, Popoola, & Jacklin, 2008).

1.4. The relationship between community pharmacy workload and dispensing errors

In their review of the incidence and causes of DEs in community and hospital pharmacies, James et al (2009) identified 13 studies which reported that WL contributed to DEs, making WL the most frequently cited factor contributing to DEs. Evidence for the impact of WL on the rate of DEs in the United Kingdom (UK) has come from studies of CP reported DEs, and qualitative interviews with CPs on this issue (Gidman, 2011). For example, the study by Ashcroft et al (2005) found that just over a quarter of all DEs (both prevented and unprevented dispensing errors) were reported by pharmacy teams to have occurred at times when the pharmacy was busier than normal. A similar study which collected pharmacists' self-reported prevented and unprevented DEs also found that times when the pharmacy busier than usual was cited as a time when DEs happened (Lynskey, Haigh, Patel, & Macadam, 2007). However, this study also found that CPs made errors when the pharmacy was quieter than normal. A self-report study carried out in the USA found that when high, medium and low (dispensing) volume pharmacies were compared, the low volume pharmacies reported the most DEs (Grasha, 2001a). It could be suggested that the low volume stores were less busy and therefore the CPs had more time to report errors than those in the medium and high volume stores. However, Grasha (2001a) proposed that this was unlikely to be the case as interviews with pharmacists indicated that mistakes occurred when they were not busy. An alternative explanation is that at times when CPs are unusually busy they are less likely to detect DEs that have been made, whereas during quiet times DEs are made but are more likely to be

detected and therefore reported. This explanation has not yet been tested but despite the drawbacks of self-report data, these studies indicate that both high and low levels of WL might relate to DEs, although they do not explain how or why.

Other factors reported to contribute to, or cause DEs in pharmacy settings are: similar drug names and packaging, type font for labels and packing, staffing levels, interruptions, skill level, knowledge, poor handwriting and time pressure (Ashcroft, et al., 2005; Beso, Franklin, & Barber, 2005; Irwin, Mearns, Watson, & Urquhart, 2013; James, et al., 2009; Phipps, Noyce, Parker, & Ashcroft, 2009). The impact these factors have on errors can be large. For example, one observational study found that dispensing errors doubled during periods of time when pharmacists were interrupted or distracted (Flynn et al., 1999). Importantly, all these factors could add to pharmacists' WL, because any work or task becomes more effortful when, for example, the pharmacist is interrupted whilst dispensing or checking, or when the handwriting of others is difficult to read. These factors also have the potential to make the task of dispensing more time consuming or feel more time pressured.

1.5. Defining pharmacy workload

It has been proposed that the measures of pharmacy WL used in past research have, with a few exceptions (e.g. Grasha & Schell, 2001; Holden, Patel, Scanlon, Shalaby, Arnold, & Karsh, 2010; Reilley, Grasha, & Schafer, 2002), been too narrow as they were limited to the physical amount of work pharmacists are required to do (e.g. dispensing volume) and staffing levels. There are several limitations to the sole use of these objective or volume-based measures of WL in this setting. These are mainly due to the attempt to measure WL as an event or as related to one task. As Figure 1.1 above (see page 5) shows, the dispensing process involves many stages. Each of these stages will likely require different mental processes and varying amounts of mental resources. For example, accuracy checking will rely heavily on short-term memory (STM), requiring the drug information on the medicine to be held in mind whilst checking this against the prescription. By comparison clinical checking will require long-term

memory (LTM) for knowledge of drug interactions or safe doses. Also, dispensing is also only one task that pharmacy teams carry out. This means that a measure of dispensing activity does not accurately capture all aspects of a pharmacist's day to day work. For example, the number of enhanced and advanced services carried out, the number of interactions with patients which do not result in a dispensed prescription, the sale of an over the counter medicine, or the consultations with other healthcare professionals (Grasha, 2001a) that occur continually throughout the day. The main limitation of these measures is that they have failed to show a consistent link to DE rates (Grasha, 2001a; Holden, et al., 2010), as increased error rates have been found at both high and low prescription volumes (Grasha, 2001a).

A volume-based WL definition also overlooks the subjective experience of WL and, in particular, the impact the work CPs are carrying out may have on the effectiveness of their mental processes (Grasha, 2001b). There is evidence from a UK pharmacy study that measured both objective measures and subjective reports of CP WL that subjective reports varied greatly between CPs and were not related to objective measures of WL (Gidman & Oppon-Agyapomaa, 2010). In other industries (e.g. aviation) the subjective experience of WL is commonly measured and seen as a robust and reliable method of assessing employee WL, particularly for tasks where safety could be compromised if errors are made. Subjective WL is more commonly referred to as the mental workload (MWL) involved in a task (Hockey, 2002).

MWL is a widely studied concept within the human factors field and is often measured when managers want to learn how busy their staff are, how complex the tasks being carried out are and whether any additional tasks can be managed over and above those already being carried out (Wickens, Hollands, Banbury, & Parasuraman, 2013). It is important to measure the MWL of tasks carried out in the workplace because some cognitive processes are limited in how much information (e.g. auditory, visual, our own thoughts) they can process at any one time. This means when we try to process too much information at once our cognitive

processes can become overloaded. However, research has shown that when MWL is very high *or* very low individuals become more susceptible to making errors (Hancock & Caird, 1993). This suggests that high and low MWL may be relevant to studies of DEs as CPs report errors when their pharmacies are unusually busy or quiet.

It is possible that when CPs have reported that their WL felt too high or was high when DEs were made, they were reporting experiences of high MWL. This is because people rarely objectively monitor their WL (e.g. "I dispensed 5 more prescriptions this hour than the previous hour"). Also the DE reports are retrospective (and subjective) reports of their WL around the time the error was made. The reports are retrospective because some DEs are not detected immediately, but leave the pharmacy and are only identified when patients report them. It could therefore be some days before a report into the circumstances surrounding a DE can be made. Furthermore, MWL is defined as the product of the interplay between the demands of the task, the expertise and ability of the individual, and the motivational and environmental context in which the task is performed (Hockey, 2002; Wickens, 1992). This means that routine pharmacy tasks e.g. checking a set of dispensed items, may be perceived as demanding or not depending on individuals' skills and expertise, their motivational level and tolerance of environmental conditions (Hockey, 2002). This definition illustrates how the factors cited by pharmacists as contributing to or causing DEs (interruptions, skill level, knowledge and poor handwriting), may be increasing or decreasing pharmacists' experiences of WL, or more specifically their experiences of MWL.

1.6. Measuring mental workload

There is a large body of evidence to suggest that individuals are consciously aware of when their MWL is too high or too low (Hockey, 2002). However, MWL can only be measured indirectly, for example through subjective reports measured by MWL questionnaires, in particular the widely used National Aeronautics and Space Administration Task-Load Index (NASA-TLX). Self-report measures have been supported by physiological indicators of the load on cognitive processes (such measures

include but are not limited to electroencephalograms and electrocardiograms) (Hockey, 2002; Wickens, et al., 2013). There is already some support from pharmacy practice research for the validity of assessing pharmacists' *perceptions* of WL using traditional MWL measures. For example, Holden et al (2010) found that pharmacists' self-reported MWL (as measured by modified versions of the NASA-TLX and Subjective Workload Assessment Technique (SWAT) scales) was significantly related to their perceptions of the likelihood that they would make or miss a DE. However, this only tells us how susceptible pharmacists feel, it does not tell us whether pharmacists go on to make a DE. Feeling susceptible to making an error does not actually mean individuals will make one. In fact it might improve their performance as individuals may invest more cognitive resources (e.g. attention) into making sure they do not make an error if they are aware of the possibility.

A team of researchers in the USA carried out several experimental studies into MWL and other psychosocial factors that may affect pharmacy tasks (Grasha, 2001a; 2002a; 2002b; Reilley, Grasha, Matthews, & Schafer, 2003; Reilley, et al., 2002; Schell & Cox-Fuenzalida, 2005; Schell & Grasha, 2000; Schell & Grasha, 2001; Schell, Reilley, Grasha, & Tranum, 2003; Schell, Woodruff, Corbin, & Melton, 2005; Tranum & Grasha, 2002). One study carried out by Reilley et al (2002) found that during a simulated accuracy checking task MWL (as measured by the NASA-TLX) did not differ between two groups of participants who were given either 72 or 120 dispensed items to check in 120 minutes. This finding is supported by research carried out by Gidman et al (2010) who looked at the relationship between objective and subjective WL reports by CPs. Schell et al (2005) found that personality traits, in particular a social anxiety trait (measured using the Grasha Holistic Stress Test), was a stronger predictor of error detection on a final accuracy check than was MWL (as measured by the NASA-TLX). Schell, Hunsaker and Kelley (2006) found that prescription checking performance was affected by individual differences in selective attention[2]. A field dependent[3] cognitive style was also found to predict

---

[2] *Selective* attention relates to what we are purposefully attending to or focusing on at any one time (Styles, 2006).

errors made by participants during the product selection and label generation stages of the dispensing process (Grasha & Schell, 2001). From this research it seems that individual differences between participants may be a better predictor of success or failure of a pharmacy task rather than objective or subjective WL. However, the participants in all three accuracy checking studies and the dispensing study, were undergraduate psychology students carrying out a simulated accuracy checking task which used nuts and bolts in place of real medicines. It is therefore unclear whether personality traits would predict accuracy checking performance when pharmacists carry out this task, because they have significantly more experience of such tasks than undergraduate psychology students. Pharmacists and psychology students may also differ in the levels of personality traits that they express. The differences in personality traits between psychology and pharmacy students and psychologists and pharmacists have not previously been measured so it is unknown what differences, if any, there are between these groups in this respect.

1.7. The impact of task expertise on mental workload

The definition of MWL outlined in section 1.5 states that expertise in the task has an effect on the level of MWL an individual will experience when carrying out that task (Hockey, 2002). The amount of MWL experienced will vary with expertise because the knowledge required to carry out a task, through practice, becomes stored in our LTM (Ericsson & Towne, 2010). This is important because LTM has no capacity limits. Until knowledge, routines, plans and schemas for how to carry out a task are

---

[3] People can differ in how much they perceive a component of a field as discrete from the surrounding field (field independent) as opposed to embedded in the field (field dependent). For people who tend to see components as embedded they are more likely to perceive a component through reference to the surrounding field (Witkin, Moore, Goodenough, & Cox, 1977). People who score high on measures of field independence like the embedded figures test that Grasha and Schell (2001) used in their study are often termed field independent and are considered to be more analytical thinkers.

stored in LTM this information is held in STM, also known as working memory (WM; see Baddeley, 2003 for a review), which unlike LTM has a very limited capacity (up to seven chunks of information (an example of a chunk is a number, or a word) (Miller, 1956)). Importantly when the task control structures needed to carry out a task are actively held in WM (as they would be by novice or student pharmacists), more attentional resources are required to carry out the task. Furthermore, any factor that draws their attention away (e.g. distracting noise in the dispensary) or requires some portion of attentional resources, may reduce a novice's performance on the task (Beilock, Bertenthal, McCoy, & Carr, 2004). Attention is the second aspect of cognition which has a very limited capacity. It is the limited capacity of WM and attentional processes that are linked to experiences of MWL because when these limited resources are stretched, tasks become effortful and frustrating. This means that novice and expert pharmacists are likely to be affected by WL or workplace pressures in very different ways. Therefore, failing to account for expertise could lead to a situation where a new policy or modified practice improves expert pharmacists' working environment, performance and MWL but has the opposite, negative impact on novice pharmacists' performance, MWL and working environment.

Currently little is known about the specific factors that can affect the cognitive processes involved in a final accuracy check carried out by a CP. It is also unclear what difference there may be in experienced and novice pharmacist in terms of the stressors that they are susceptible to. Previous research has also been unable to directly test whether the community pharmacy WL is overloading or underloading community pharmacists' cognitive processes and contributing to the occurrence of DEs.

1.8. The aim of this doctoral research

The aim of the doctoral research presented here was to directly measure the relationship between MWL and DEs under controlled conditions whilst accounting for the impact of task expertise on the levels of MWL reported. As accuracy checking has been identified as a key stage of the dispensing process which aids DE prevention this doctoral research

specifically studied the relationship between DE rates and MWL experienced when accuracy checking. This relationship was studied through simulated accuracy checking tasks (the experiments reported in chapter 4). Expertise was accounted for by inviting both final year pharmacy students (novice pharmacists) and CPs currently in practice (expert pharmacists) to take part in this research. Pharmacy student and CP participants were invited to carry out simulated accuracy checking tasks of dispensed medicines and report the levels of MWL and other mental states they experienced, under different WL conditions. This experimental research was supported by a field study which measured the amount of MWL CPs experienced throughout the day. This study is reported in chapter 5. Qualitative interview studies with CPs and pharmacy students were also conducted to learn more about the factors that they felt affected their perception of WL when working in a community pharmacy and to learn about their experiences of MWL. This research therefore represents a study of MWL and DEs grounded in the CPs' experience. The original contribution of this research lies firstly in the comparison of MWL and DE detection rates between novice and expert pharmacists under different WL conditions, the measurement of MWL in UK community pharmacy practice (MWL diary field study) and the exploration in qualitative interviews of the factors perceived by novice and expert pharmacists to affect their MWL.

1.9. The structure of this thesis

This thesis is structured in chapters which reflect the development of the research ideas and each stage of data collection.

Chapter 2 presents the conceptual framework for the research which was used as the structure for the narrative of this literature review. The DE literature is discussed and related to theories of human error and human cognition. The theories of cognition which underpin the use of MWL as a tool for identifying when WL may contribute to safety issues are reported. Reference is made to how human factors research and practice has been used to improve safety in other areas of healthcare and other industries. The chapter also presents a review of the development of the human

factors field and why healthcare systems have failed to use insights from this field to improve safety. The chapter concludes with the aims and objectives of the research.

Chapter 3 outlines the methodology that underlies the methods used in this doctoral research. As this doctoral research involves mixed methods (both quantitative and qualitative methods) the different philosophical perspectives and the advantages and disadvantages of using mixed methods to study the impact of MWL on DEs are discussed. This chapter ends with how the different methodologies are utilised in this research and how the data from each study will be synthesised.

Chapter 4 presents the findings of two simulated accuracy checking experiments. The chapter begins with the details and findings of the pilot study which informed the design of the two accuracy checking studies. The results of the accuracy checking studies are then presented. These results are then discussed in relation to the literature presented in chapters 1 and 2.

Chapter 5 presents the results of the diary study into the amount of MWL that community pharmacists experienced during a day at work. Before the results are presented the supporting literature, rationale and methods used for this diary study are outlined. The results of this study are discussed in relation to the supporting literature.

Chapter 6 outlines the findings of the qualitative interviews with CPs and pharmacy students. This chapter begins with a review of previous qualitative research which has explored pharmacy WL, DEs and CP wellbeing. The method chosen for this study is Interpretative Phenomenological Analysis (IPA) and the rationale for choosing this approach is detailed before reporting the findings from the interviews with CPs and pharmacy students. The qualitative findings are discussed in relation to the qualitative studies reviewed at the beginning of the chapter.

Chapter 7 draws the findings reported in chapters 4, 5 and 6, together to be triangulated. This chapter provides an in-depth picture of the relationship found by this research, between MWL and DEs in community pharmacies.

The triangulated findings are discussed in the context of the literature presented in chapter 2, and in relation to the conceptual framework used for this research. Directions for future research are also considered.

Chapter 8 presents the conclusions of this research, the implications of this research for community pharmacy practice and teaching and recommendations for future teaching and practice.

1.10. The brain images

Each chapter will begin with an image from the "blank brain competition" (see: http://errorgirl.com/the-blank-brain/blank-brain-entries/) which was run during the data collection period and CPs who took part in the study and CPs from around the UK were invited to take part for the chance to win a small prize (a £50 amazon voucher). The image at the beginning of this chapter was drawn by me at the time I was reviewing the literature and captures many of my initial thoughts of what MWL might look like for CPs. This image then led to the idea for the blank brain competition. This competition was not conducted for any purpose other than to engage with CPs about MWL. However the competition in itself turned out to be a very useful tool to learn more about the things that were on CPs minds at work and the pressures they perceive. The images chosen for the beginning of each chapter exemplify the themes discussed in each chapter of this thesis. Each image is also accompanied by a quote from the qualitative study reported in chapter 6.

Chapter 2: Literature Review

"I guess for instance I come in and there is a whole stack of stuff then that is actually a workload sort of thing, so that is when the **cogs sort of break up**, they just it sort of goes to pot, that is when it is so called harder to concentrate on what you are doing at that point in time without thinking about everything else, that is when it becomes harder."

Community Pharmacist 67

2.1. Overview of the chapter

This chapter presents a narrative review of the literature relating to DEs and MWL. The review is structured around the conceptual framework for this research, which is based upon the Cognitive Systems Model (CSM; Grasha, 2001b; 1996; Grasha & Schell, 2001). The CSM was proposed and used by Professor Anthony Grasha and his colleagues to research the factors which may contribute to DEs in community pharmacies in the USA. The CSM includes both the human and systems factors which may lead to DEs. The model draws on contemporary theories of cognition and human error, and combines knowledge from human factors and organisational psychology to provide a holistic approach to understanding DEs. The CSM also accounts for pharmacists' experiences of MWL and how it might be related to DEs. In this chapter each aspect of the model is considered in turn. The chapter concludes with the aims and objectives for this research.

2.2. Reviewing the literature

A narrative approach was undertaken so that this review could be informed by the many research disciplines that have studied safety issues, human error, DEs, WL and MWL, which would be difficult within the stricter confines of a systematic review. However, in the initial stages of this doctoral research a more systematic approach was undertaken in order to learn what is already known about the relationship between MWL and DEs, and the factors which have been studied in relation to DEs made by CPs. Five online literature databases (Embase, PubMed, Web of Knowledge, Google Scholar and APA PsychNET) were searched using the terms described in Table 2.1 below. Throughout this chapter research findings published to date on CP WL, MWL and DEs are discussed in the context of the factors highlighted by the CSM.

Table 2.1: Terms used for the literature search

Accuracy Checking	Dispensing errors (DEs)	Mental Workload (MWL)	Factors affecting pharmacy performance
Pharmacy verification task	Medicine errors	Pharmacist workload	Pharmacist performance
Pharmacy quality control	Medication errors	Subjective workload	Human factors (and pharmacy)
Pharmacy checks	Pharmacist errors	Perceived workload	
	Pharmacy errors	Mental Stress	
Dispensing safety	Checking errors	Mental overload	
Dispensing quality	Medicine label errors	Cognitive load	
	Causes of DEs	Cognitive workload	
	Incidence of DEs	Task load	
		Role overload	
	DE rate		

Notes: (1) Many terms are used to refer to the same concept, practice, or theory and therefore these are grouped under a key term, or heading. (2) A specific search term for CP was not used so that articles discussing workload, errors and accuracy checking for both hospital and CP were not missed.

2.3. The Cognitive Systems Model

Professor Anthony Grasha, a psychologist who was interested in reducing the DEs made in pharmacies, with his colleagues Dr Kraig Schell (also a psychologist) and Michael O'Neil (a pharmacist), proposed a framework called the Cognitive Systems Model (CSM; Grasha, 2001b; Grasha & O'Neill, 1996; Grasha & Schell, 2001) which could be used to study the relationship between MWL and other variables which could contribute to DEs. Figure 2.1 below depicts the CSM.
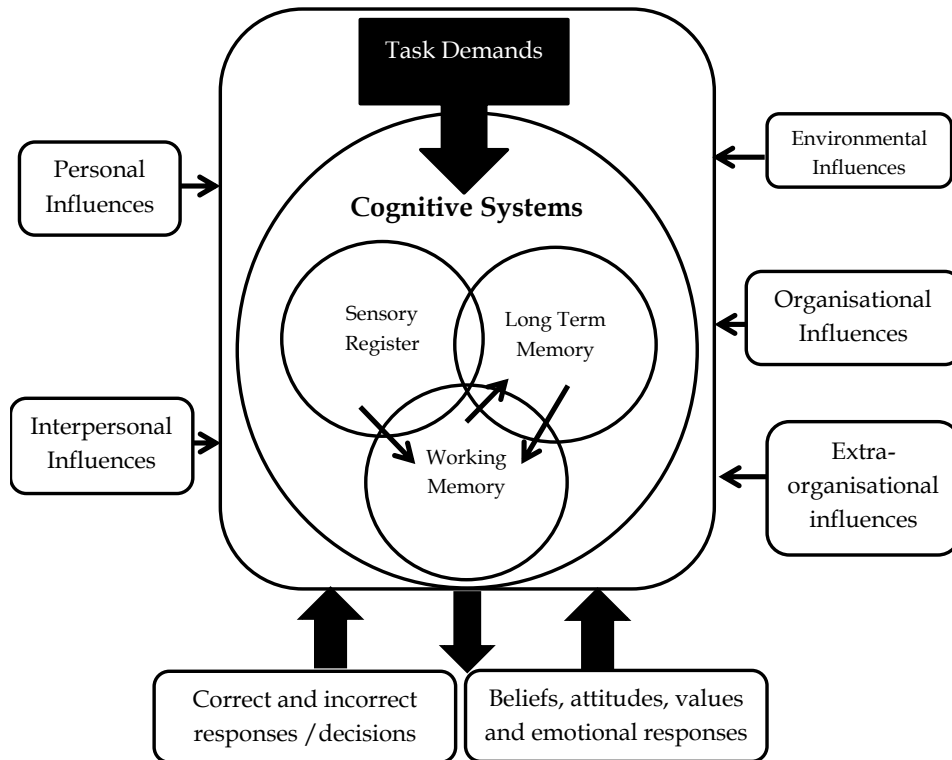
Figure 2.1. The Cognitive Systems Model (adapted from Grasha, 2001b)

The CSM is based on contemporary theories of cognition including human information processing (Wickens, et al., 2013; Wickens, Lee, Liu, & Gordon Becker, 2004) and working memory (WM; Baddeley, 2003; Baddeley & Hitch, 1974) these models are discussed later in section 2.4. The CSM demonstrates how human information processing (the cognitive systems) and subsequent task or work performance are adversely or favourably affected by a variety of given psychosocial factors. The psychosocial factors specified in the CSM include the subjective and objective features of the task (e.g. task complexity, time pressure and time allotted to complete the task), the characteristics of the person carrying out the task (e.g. age, gender, personality traits), interpersonal relationships (e.g. at work and outside of work), organisational characteristics (e.g. organisational roles and norms, supervisory practices), extra-organisational influences (e.g. interfaces with boards of pharmacy, governmental and commercial pressures on pharmacy) and the physical environment (e.g. levels of illumination and noise) (Grasha, 2001b). The underlying assumption of the CSM is that interaction of psychosocial factors with the characteristics of the task and the individual's cognitive system can produce tension and

stress which may reduce the effectiveness of their cognitive processes. Therefore, in this model, MWL is seen as a subjective component of the impact task and environmental elements have on the performance of individuals' cognitive systems (Grasha, 2002b).

This model is used as the conceptual framework for this research because it synthesises knowledge and theories from many fields of psychology with pharmacy practice. As well as referring to contemporary models of cognition the influences of human error research can be seen in the CSM. Both the person (e.g. personal influences, cognition) and systems approach (e.g. organisational and task characteristics) to understanding errors is included in this model (these approaches are discussed in section 2.6 below). Using this model as a framework, knowledge from the broader fields of human factors and organisational psychology can also be applied when seeking to understand the role of the organisation and work environment, or the impact of individual differences on human performance.

Whilst this model provides a suitable conceptual framework, there are some gaps. For example, it does not explicitly include a role of attentional processes, despite their importance to models of human information processing, MWL and task performance. Attentional resources are implicated and encompassed within the theory of WM. However, this provides an incomplete description of the role of attention in information processing, and human error. The roles of attention and WM are discussed below, after an introduction to the information processing approach to understanding human cognition.

2.4. Models of cognition

2.4.1. Human information processing

The information processing approach to cognition and human performance was first proposed by Donald Broadbent. He suggested that psychological processes could be understood in terms of the flow of information within the nervous system (Broadbent, 1958; Styles, 2006).

Included within the CSM are the key aspects of our information processing system; the sensory register, LTM and WM (Grasha, 2001b; Grasha & O'Neill, 1996; Grasha & Schell, 2001).   Figure 2.2 below shows a more detailed model of the human information processing system as it is currently conceptualised (Wickens, et al., 2004). Importantly this model of information processing also includes attentional resources which are not included in the cognitive systems performance model, but are very important to the understanding of MWL and the functioning of the human information processing system.
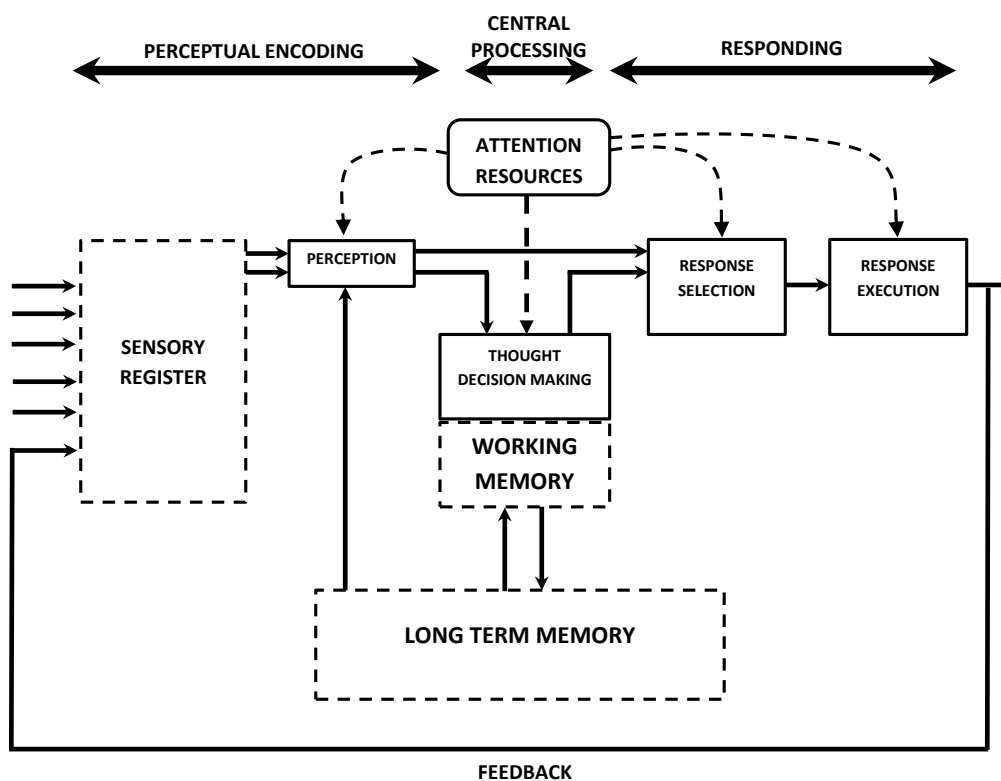
Figure 2.2. A model of human information processing (from Wickens, et al., 2004, p.122 with permission)

Using this model of human information processing the cognitive processes that are involved when a pharmacist carries out an accuracy checking task can be considered. First the pharmacist uses their senses to gather information about the dispensed item and prescription they are checking. Their eyes providing information on the visual appearance of the prescription and dispensed item, and as they hold the medicine somatosensory information about how the medicine feels (e.g. weight) (Wickens, et al., 2004). This raw un-coded sensory information hits the

sensory register where it is stored very briefly (1-4 seconds) and filtered to identify what information will be processed (G. Cohen, 1993). This filtering happens in two ways, first, certain sensory information will capture the pharmacists' attention (e.g. telephone ringing in the background) and other information will be purposefully selected as it is related to the task at hand (Wickens, et al., 2004). This also means that other information may be blocked from processing (or tuned out) in order that the information selected for processing can be processed effectively. In the case of accuracy checking, sensory information relating to the prescription and medicine is selected. Sensory information that is not selected decays. The information selected for processing is then perceived, i.e. the pharmacists' brain produces a meaningful interpretation of the sensory information through interaction with the long-term memory (LTM) stores, where their prior knowledge is stored.

Perception can lead straight to response selection and execution (i.e. the pharmacist decides that the medicine and label match what has been requested on the prescription) (Wickens, et al., 2004). However, this depends on knowledge and expertise and often the response selection and execution is delayed whilst the perceived information is manipulated in WM (Baddeley, 2003) and paired with other knowledge and experience to form a decision (Wickens, et al., 2004). For example the pharmacist may pause to consider whether the patient has had this medicine before in this dose. Once the pharmacist has decided they have considered all the information (or sufficient information), they will then select a response and execute it. It is important to note that a feedback loop is also included because individuals routinely monitor and perceive their own actions in order to check that these actions are carried out correctly and successfully (Wickens, et al., 2004, 2013).

2.4.2. Attention

Figure 2.2 above shows that all but one of the stages of information processing (sensory register) relies on attentional resources. Attentional resources are generally considered to be a pool of resources which can be allocated and divided between tasks as required. Two types of attention

are distinguished in the literature and in the description in section 2.4.1, selective and divided attention. *Selective* attention relates to what an individual is purposefully attending to or focusing on, at any one time, and is required for (but does not guarantee) perception. *Divided* attention relates to the ability to attend to more than one thing at once (Wickens, et al., 2004). Many theories have been proposed to explain how selective and divided attention occurs. These theories are discussed in the following two sections.

Selective attention

Broadbent saw the role of selective attention as a filter protecting the human information processing system from overload, this idea formed the basis of his Filter Theory of selective attention (Broadbent, 1958). In this model parallel processing of sensory information occurs up to the selective filter, after this filter processing of information occurs in a strictly serial manner. Broadbent suggested that the information that passed through the filter (so was selected) became the information which was consciously processed and the only information which could modify LTM or be processed for storage in LTM (Broadbent, 1958; Styles, 2006). This means that according to the filter model only information which passes through the filter can be semantically processed (Styles, 2006).

Challenges to the Filter Theory came when experiments tested the placement of the filter or bottleneck as it is also often referred to. Experiments showed that information which isn't being selectively attended to can be semantically processed and is available to consciousness (e.g. Cherry, 1953 - the "cocktail party effect"; A. M. Treisman, 1960). Research also found that semantic processing can occur at an unconscious level (Corteen & Dunn, 1973). In this study participants heard a list of words, and a small shock was administered at the same time as words related to the city were presented. In the second stage of the study participants were given a dichotic listening task to do, where participants listen to a different set of speech in each ear and are instructed to only attend to one ear. A galvanic skin response (GSR) was observed when the city words were presented on the on the unattended channel of

the dichotic listening task. Semantic processing was proposed to have occurred because a GSR was also seen for words which weren't paired with the shocks, but were semantically related with these words (Corteen & Dunn, 1973). This led to "late selection" theories being proposed (Filter theory is therefore an "early-selection" theory).

For many years the placement of the bottleneck was debated. However, a more recent theory, the Load Theory of Attention and Cognitive Control (Lavie, Hirst, De Fockert, & Viding, 2004) may resolve the early-late debate. Load theory suggests that perception has a limited capacity, and tasks involving high perceptual load will leave no spare capacity for the processing of distracting information. Under these conditions early selection of information will be observed. Late selection and processing of distractor information will be seen when the primary task, or the information that is being selectively attended to, carries a low perceptual load and there is available capacity to process this information. In this model perception is seen as an automatic process and so processing of distractor information cannot be blocked when perceptual load is low. This has implications for pharmacy practice, for times when CPs describe their WL as low as they may be more susceptible to distractions at this time. This model also suggests that the prevention of distractors gaining control over behaviour depends on the amount of load on cognitive-control mechanisms like WM (which is discussed below in section 2.4.3) (Lavie, 2005; Lavie, et al., 2004). Load Theory of Attention and Cognitive Control therefore has implications for safety critical systems and environments, as simply asking people to "pay attention" will not be sufficient to stop distracting information being perceived (as this is proposed to occur automatically) and if the WM load of a task is high then a person's ability to prevent distractors influencing or diverting attention from the primary task will be low. Before the importance of WM to control of attention is considered, divided attention theories are reviewed.

Divided attention

Multitasking is a common occurrence in community pharmacies (e.g. a pharmacist may monitor the interactions occurring between the medicines

counter assistant and patients whilst checking a prescription). It is also a common feature of everyone's day to day lives (Wickens, 2008). Theories of attention need to be able to account for both selective and divided attention. One issue with Broadbent's Filter Theory introduced above, is that it is difficult to conceive how individuals might carry out two tasks at the same time if information that flows through the filter is processed serially. According to filter theory dual-tasking occurs through time-sharing or rapid switching of attention between tasks (Broadbent, 1958; Styles, 2006). Evidence to support this proposition, came from early experiments conducted by Welford (1952). Welford was interested in why pilots and air traffic control teams struggled to respond to information coming from several different channels at the same time. Welford's experiments found that when two pieces of information (or signals) are presented in rapid succession, the amount of time between the onset of the first and the onset of the second signal affects the individual's reaction time to the second signal. So when there is little gap between the presentations of two signals the response to the second signal will be more delayed. He called this the psychological refractory period and it was evidence that there was a bottleneck in response selection and execution (Styles, 2006; Welford, 1952).

Other researchers found evidence which suggested there wasn't a single channel for attentional processing (and therefore no bottleneck). For example Allport, Antonis and Reynolds (1972) asked keyboard players to shadow prose whilst at the same time playing a piece of music they had not seen before. Allport et al (1972) found the keyboard players were able to carry out both tasks at the same level of performance as they did when they carried out each task separately. Allport et al (1972) suggested that participants' ability to carry out both these complex tasks at the same time could not be supported if participants were rapidly switching attention between the two tasks or time-sharing of attention was occurring. Allport et al (1972) based this suggestion on the assumption that both tasks required continuous attention in order to be able to keep up with the pace of the task. This assumption was later criticised by Broadbent (1982) who suggested that the high level of information redundancy in language

would mean that constant attention may not be required for the shadowing task.

An alternative theory had been proposed in 1967 by Moray who suggested that instead of a time limited single processing channel there was a limited capacity central processor that in dual-task situations could be shared (Moray, 1967; Wickens, 2002). Human factors research and practice which has informed this doctoral research adopts Moray's approach. More precisely, human factors research and practice is underpinned by the idea that the human information processing system has a limited capacity which affects the number and complexity of tasks that can be carried out at any given moment (Wickens, 2002; Wickens, 2008). This approach is discussed below in relation to Wickens' Multiple Resource Theory.

2.4.3. Multitasking and Multiple Resource Theory (MRT)

Wickens (2002; 2008) proposed the Multiple Resource Theory (MRT) which attempts to predict when multitasking (or dual-tasking) may lead to performance decrements. Wickens (2002) states that MRT is designed to predict performance in high WL, multi-task environments and gives the examples of driving a car in traffic, or a secretary working in a busy office. This could also easily apply to a pharmacist or member of the pharmacy team working in a busy community pharmacy. Research carried out by Treisman and Davies (Treisman & Davies, 1973) found that dual task performance was better when two different modalities were used. This and other evidence led Wickens to propose the four-dimensional multiple resource model pictured in Figure 2.3 below.
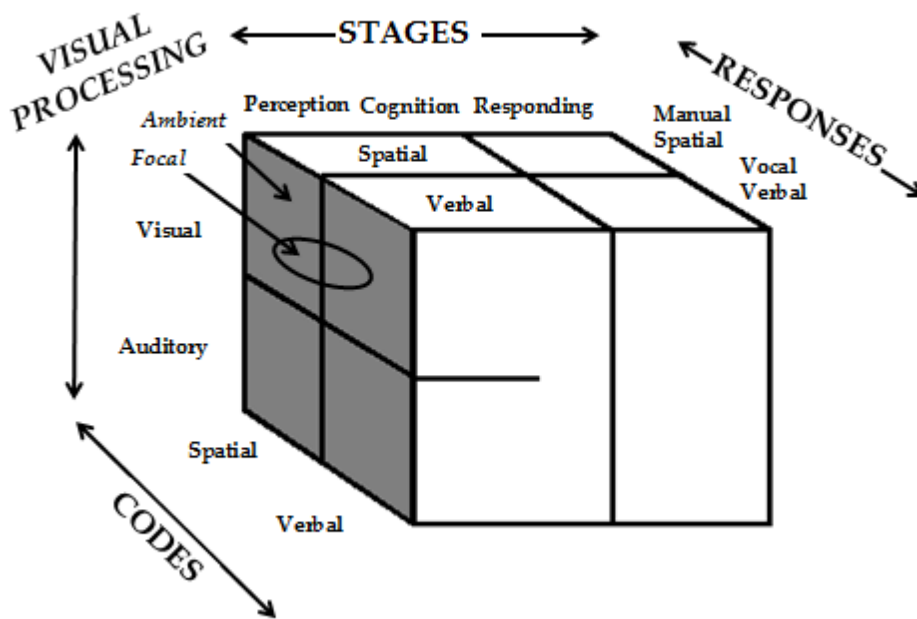
Figure 2.3. The Multiple Resource Model (from Wickens, 2008, p. 450, with permission)

This model suggests that there are four dimensions (modality, stage, processing codes and visual channels) that account for performance in multi-tasking situations and that each dimension has two levels (Wickens, 2002). For example, multi-tasking performance will be superior when the two tasks access two different *perceptual modalities*, i.e. the visual and auditory modalities on the vertical axis on Figure 2.3 above compared to when they both use the same modality (e.g. two auditory tasks). The *stage* of processing is also important, so tasks which are primarily perceptual or cognitive in nature seem to involve separate resources to those involved in the selection and execution of responses. Wickens (2002) gives the example of an air traffic controller who is asked to vocally or manually acknowledge a change in aircraft state (a response demand). This task would not interfere with their ability to hold an accurate mental picture of the current airspace at the same time (perceptual demand).

The *processing code* is also important when tasks are combined. The different codes can either be spatial/analogue or linguistic (also termed symbolic). Irrespective of the stage of processing (described above) when

one task is spatial and another is linguistic these are easier to combine than two using the same codes (i.e. two spatial tasks). The fourth dimension of this model is the *visual channel.* There are two different aspects of human vision, *focal* vision, which is required for fine detail and pattern recognition, for example, reading words, and *ambient* vision, which is peripheral vision, and aids our spatial awareness. These two types of vision can be used successfully at the same time. For example, driving a car whilst at the same time reading road signs utilises both focal and ambient vision (Wickens, 2002). The same could be said of pharmacists who are checking a prescription yet maintaining awareness of the activities going on around them.

All four of these dimensions need to be considered when identifying whether two tasks can be carried out efficiently and safely at the same time (Wickens, et al., 2013). An example of when a pharmacist or a member of pharmacy staff might multitask is when they are entering patient data on the patient medication record in order to generate a medicine label they may also be listening in to what is being said to a patient by a medicines counter assistant. In this example the processing code is the same, as linguistic processing codes are required for reading and typing of information onto the computer and to process the content of the conversation that they are monitoring. Therefore an error may be made on the primary task (entering the patient data onto the patient medication record for the label). For the same reason accuracy checking whilst monitoring of conversations may increase the risk of missing an error on the medicine label.

Wickens' model outlines the cognitive factors which limit or allow multi-tasking to occur. However, human factors also emphasises the role of the non-cognitive or psychosocial factors that are outlined in the CSM above (e.g. personal influences, organisational influences see page 20 for the model) which affect whether two tasks can be carried out concurrently (Styles, 2006). The specific effect of these psychosocial factors on attention and other aspects of cognition are discussed later in this chapter.

2.4.4. Memory

Although it was a model of attention, Broadbent's filter theory (Broadbent, 1958) inspired several multi-store models of memory (Eysenck & Keane, 1995). For example Atkinson and Shiffrin (1968) proposed three types of memory, the sensory stores (akin to Broadbent's sensory buffer stores) which hold modality specific information for 1-4 seconds), the short-term store (which holds up to 7 chunks of acoustic or visual coded information for 6-12 seconds) and a long-term store (of unlimited capacity which holds information for long periods of time) (Atkinson & Shiffrin, 1968; G. Cohen, 1993; Eysenck & Keane, 1995). In this model, the memory stores form the structure of the system and attention and rehearsal allows transfer of information along these stages (Eysenck & Keane, 1995). Looking at Figure 2.2 above (see page 22) this multi-store model can be seen in the information processing model (Wickens, et al., 2004; 2013). This multi-store model therefore holds largely true today. What has developed in the field of memory is the detail of specification of processes that occur within each of these three memory systems and what systems underpin them. With short-term memory (STM) in particular, it became clear that the capacity limit of this store was related to the allocation of attention; there are only so many things that can be attended to at one time (G. Cohen, 1993).

Working Memory (WM)

The realisation that STM was limited by the processing capabilities of attention led to STM being considered as a mechanism for actively allocating attention (G. Cohen, 1993). This led to the development of the theory of WM proposed by Alan Baddeley and Graham Hitch (1974) who suggested that STM should be considered as actively involved in any cognitive task that involved conscious thought (G. Cohen, 1993). The model of WM that Baddeley and Hitch envisioned was a multi-component system rather than a unitary store (Baddeley, 2003). The current version of the model of WM is shown below in Figure 2.4.
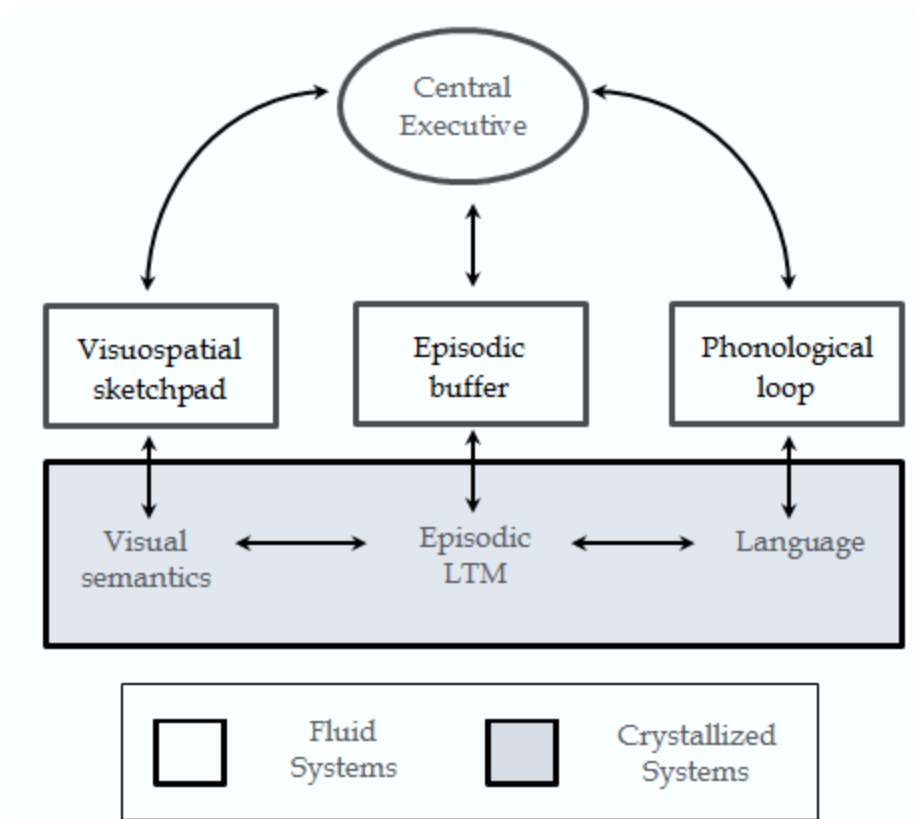
Figure 2.4. Model of Working Memory (from Baddeley, 2003, p.835, with permission)

Baddeley and Hitch's model of WM has four subsystems, the central executive, the phonological loop, visuospatial sketchpad and the episodic buffer (Baddeley, 2003, 2012). The model also refers to crystallized and fluid systems. Crystallized systems are a person's acquired knowledge of language, information and concepts of a specific culture. It is a store of language-based declarative and procedural knowledge acquired over an individual's life span through interaction with their culture, general life experiences, informal and formal education. Later in this section theories relating to crystallized systems, or LTM processes are outlined. Fluid systems refers to the intentional mental operations that occur when individuals, for instance, solve novel, "on-the-spot" problems, make inferences, generate and test hypotheses, extrapolate and transform information (McGrew, 2005).

The *phonological loop* is based on sound and language. It has both a phonological store for memory traces which last for a few seconds before

they decay, and an articulatory loop which allows memory traces to be refreshed in the phonological store and maintained. The requirement for sub-vocal articulation to keep memory traces present in WM sets strict capacity limits on the phonological loop. The phonological loop aids the perception of speech but it also has an articulatory process which links with the phonological store to support speech production (Eysenck & Keane, 1995). In earlier versions of the model, the phonological loop and visuospatial sketchpad were defined as slave systems however there is evidence that the phonological loop can also exert action control (Baddeley, 2003).

The *visuospatial sketchpad* is the visual equivalent of the phonological loop. It also has strict capacity limits of around 3 to 4 objects which makes ecological sense as the visual world remains stable from moment to moment. So capturing all visual information in a scene time and time again is redundant. However, this capacity limit does lead to bizarre effects, for example, change blindness where people can miss large changes in visual information in their environment (Baddeley, 2003, 2012). Neuropsychological evidence suggests the existence of two separate pathways in the visuospatial sketchpad. One of the pathways processes visual information about an object, and the other processes spatial information about where that object is in space and movement (Baddeley, 2003; Della Sala, Gray, Baddeley, Allamano, & Wilson, 1999). This distinction was also drawn in Wickens' (2002; 2008) MRT reported in section 2.4.2 above.

In earlier versions of the WM model a mechanism to allow the phonological and visuospatial systems to interact was not included. This was resolved by the addition of the *episodic buffer* which also has a limited capacity and combines the two sets of information and is accessible to conscious awareness. It also links WM to perception and LTM. The capacity of the episodic buffer is believed to be four chunks of information (or multidimensional representations as it combines the information from the visuospatial sketchpad, the phonological loop and stored knowledge from LTM) (Baddeley, 2012).

The *central executive* is the final aspect of the model and least understood aspect of WM due to its complexity (Baddeley, 2003, 2012). Originally defined as an attention control system capable of attentional focus (as well as dividing attention), decision making and storage (Baddeley, 2003). The central executive was initially related to Norman and Shallice's (1986) model of attentional control. Norman and Shallice's (1986) model suggested that behaviour was controlled by schemas (for learned habits, processes, skills) which were activated by cues from the environment. This activation of schema was overseen by an attentional control system (supervisory activating system) which could intervene when routine control was inadequate (Baddeley, 2003). Evidence for control of behaviour through schema came from action slips (Norman's taxonomy of action slips is discussed below in section 2.6.1). Evidence for the supervisory activating system was also observed in patients who had frontal lobe damage who exhibited excessive distractibility and perseveration of behaviour (repeatedly doing a task e.g. ringing people on the telephone over and over again) (Baddeley, 2003). The role of the central executive has since developed beyond a limited capacity attentional control system to a system which interacts with LTM through the episodic buffer.

In this brief review of WM it is clear that all aspects of STM are capacity limited which has implications for task design and working environments. Tasks that involve assimilation of large amounts of visual or auditory information, beyond the capacities of the visuospatial and phonological stores, will be difficult for individuals to carry out successfully. Tasks that require dividing attention rely on the capacity of executive control systems and this could easily be exceeded. It is also important to note that WM is assumed to underlie all conscious thought processes, and so this will also include task irrelevant thoughts when at work (e.g. "what to cook for tea tonight?" or concern about family members). Therefore, when designing tasks or considering MWL, one needs to consider the amount of WM capacity used when employees are thinking about non-work related things.

The capacity limits of WM are also related to how much information is already stored in LTM and how much expertise you have for a task, or in a particular field. This is because as individuals become more expert in an area they learn to chunk information more efficiently in WM allowing for greater capacity (Wickens, et al., 2013). For example each medicine will only come in certain doses or forms, therefore the drug, dose and formulation information could be chunked together in WM once a CP becomes familiar with those drugs. The processes that underlie LTM are now discussed.

Long-term memory (LTM)

LTM is assumed to be a store, or set of parallel stores of highly inter-connected neuronal units. New information is assumed to be stored in LTM through a process of activation and inhibition of the neural connections, through this process existing memories can also be modified (Rumelhart & McClelland, 1986; Sharit, 2006). As new knowledge is stored LTM stores are constantly being reconfigured through the strengthening and weakening of connections and the building of new ones. Unlike WM, no capacity limits have been observed for LTM (Eysenck & Keane, 1995). However, the architecture of LTM does lead to biases in the information cued and recalled, which can be problematic in complex systems. Before the limitations in the retrieval process are considered, the different types of information stored in LTM are outlined.

There are many different types or kinds of memories that are held in LTM. For example memories for what things or people look like, of events in a person's life and memories for skills and knowledge in many different fields. This has led researchers to theorise that there may be different LTM stores for specific types of information (Eysenck & Keane, 1995; Sharit, 2006). Tulving (1972) distinguished two types of memory *episodic* and *semantic* memory. *Episodic* memories are those that relate to events that have happened in day to day life, for example, everyday things like breakfast this morning. Episodic memories also include less routine events like a friend's wedding. *Semantic* memories concern our knowledge of the world, e.g. language (Eysenck & Keane, 1995).

Semantic and episodic memories are two forms of *declarative* knowledge, which are memories relating to "knowing that". Thus people know that they had breakfast this morning (episodic), and that London is the capital city of England (semantic). There is another type of LTM, *non-declarative* (originally termed procedural knowledge), which is knowledge for how to do things, for example, skills such as riding a bike (Eysenck & Keane, 1995). Non-declarative memories also included habits, conditioned responses and primed memories (Squire, 1992). The distinction between declarative and non-declarative memory was proposed by Cohen and Squire (1980). The term declarative was used because semantic and episodic memories can be declared, whereas the knowledge that is involved in skills and habits cannot be reported, and don't need to be for the skill to be carried out (Squire, 1992). Declarative and non-declarative memories have also been termed explicit and implicit memory (Graf & Schachter, 1985). As an individual becomes more expert at a task (or in their chosen field) they gain more implicit and explicit knowledge and rely less on WM when they are carrying out tasks (Ericsson & Towne, 2010). From the descriptions above it is clear that CPs will have both declarative and non-declarative memories that they use on a day-to-day basis in their work.

Habits and attitudes are another type of knowledge which can affect human behaviour and the way work is carried out, without conscious realisation on the part of the individual (Squire, 1992). This is why it is important to carry out research that allows the study of DEs in ways that do not rely on self-report measures of why or how errors occurred. Knowledge and skills may have been used without the pharmacist consciously realising it, and therefore they cannot report this information.

The processes by which memories are stored and retrieved from LTM can lead to errors. A common storage issue is cognitive underspecification, where knowledge on a topic or event is incomplete because WM or perceptual constraints led to only a portion of the necessary information being captured (Sharit, 2006). Although many issues can occur in the retrieval of memories, the issues which are of most relevance to DEs are

the use of cognitive shortcuts in decision making. When making a decision, answering a question, solving a problem or carrying out a task humans prefer to use minimal cognitive effort (Sharit, 2003). WM constraints also mean that all the possible information from LTM cannot be retrieved to be considered. This leads to the use of mental shortcuts and heuristics. For example, more recently activated memory traces, and memories that have strong links (and are therefore easier to recall) because they have been frequently used are more likely to be retrieved from LTM than those are less frequently recalled. This is called the availability heuristic (Sharit, 2006). An example of this in a pharmacy setting would be the recommendation made by a pharmacist to a patient with a cough to use a specific brand of over the counter cough medicine over others because this was the one which they most recently read the information on, or the one which most patients ask for because they saw the advert for it on the television (Donyai, 2012).

A second cognitive shortcut is satisficing, where the plan of action or mental model that is a good enough fit for the situation is chosen instead of continuing to search LTM. A complete search of LTM would be time consuming but also would produce many results which would require a large amount of WM capacity to weigh up each of these options (Sharit, 2006).

Other heuristics and biases that can occur during the retrieval of information are: cognitive fixation (failure to re-consider a plan of action in the light of new information), confirmation bias (ignoring disconfirming information), and the representativeness heuristic (Donyai, 2012; Sharit, 2006).

Heuristics and biases are one reason why pilot crews are intensively trained in aeroplane simulators before flying a new type of plane. By training pilots in simulators, the correct responses to new situations can be learnt instead of pilots relying on searching their LTM for previous similar experiences (which would likely involve cognitive shortcuts) to solve new problems whilst in the air.

2.5. Mental Workload (MWL)

The information reviewed above describes how WM and attentional systems are capacity limited. The noticeable impact this has on the individual is that tasks will feel effortful, or they will experience tension when most or all of their WM or attention resources are being used. This experience directly relates to the concept of mental overload and MWL. Having considered in detail above how a pharmacist's cognitive processes might be working when carrying out a final accuracy check, it is clear to see how the psychosocial factors identified in the CSM (see Figure 2.1 on page 20) may interact and impact on the amount of MWL experienced by a pharmacist. For example a one item prescription may utilise less WM space compared to a multi-item prescription to accuracy check. A noisy working environment will lead to more divided attention (so more attentional resources) and possibly WM space being used if the pharmacist is actively monitoring or thinking about the noise around them.

2.5.1. Defining mental workload

It is impossible to physically see what mental processes are occurring as an individual carries out a task. However the demands placed on an individual's mental processes when they carry out a task can be conceptualised based on what is already known about human cognitive processes. One such concept is MWL. MWL is and has been one of the most widely researched and measured topics in human factors (Proctor & Vu, 2010). Despite this, there is no widely accepted definition of MWL within the research literature (Byrne, 2011; Xie & Salvendy, 2000). A review of the MWL literature showed that the definitions used are many and varied as can be seen from those reported in Table 2.2 below. To summarise the definitions in Table 2.2 below, MWL can be considered as a multidimensional construct that describes the demands made of an individual's limited information processing capacity. The level of demand made is the product of the interplay between an individual's characteristics (their skill and expertise at the task and motivation to carry out the task), the environment in which the task is carried out and the task characteristics (e.g. time available to carry out the task). The definitions in Table 2.2 also refer to several models of cognition for example information

processing and models of attention (these have been discussed above in section 2.4). Finally, the definitions also use different terms for MWL, including workload, mental load, cognitive workload and cognitive load (Block, Hancock, & Zakay, 2010). In their discussion of the definition of MWL Gopher and Donchin (1986) comment that the concept of MWL is only needed for those cases where the level of performance required is clearly within the performer's abilities.

Researchers have failed to reach a consensus over the definition of MWL, however, the International Organization for Standardization (ISO) produced a series of documents relating to the definition, measurement of and use of MWL in the workplace to create safer work systems. These documents were published between 1991 and 2004 and are the current standards used by industries which employ human factors and ergonomic principles in the design of work and work systems, around the world. These documents can be seen as the gold standard as the ISO has representative members from standards bodies of 163 countries around the World (ISO, 2013). When international standards are drafted member countries are asked to vote on the standard's acceptability (Nachreiner, 1995).

The first of these standards ISO 10075:1991, which outlined the general terms and definitions relating to MWL, took ten years from its conception to completion indicating the complexity of this topic (Nachreiner, 1995). The definition outlined in IS 10075: 1991 is based on a stress-strain model where performance, physiological markers and mood states are compared with and without a stressor present. Throughout the stress literature a stressor is considered to be environmental (e.g. noise), individual or psychological (e.g. anxiety), task related (e.g. time pressure), or organisational (e.g. financial penalties or incentives based on performance) (Wickens, et al., 2013). The stress-strain definition adopted by the ISO states that mental stress is caused by external influences to a person that affect their mental processes (i.e. the environmental, organisational, task related stressors identified in the CSM (see Figure 2.1 on page 20)). Mental strain is related to the immediate impact that mental stress has within the

individual (i.e. the psychological response), which varies in relation to the individual characteristics and coping style of the person (ISO, 1991; Nachreiner, 1995). Although MWL is generally associated with tasks which require information processing or mental work, the ISO standards make it clear that any human activity - even those which are primarily physical - will include mental abilities (Nachreiner, 1995).

2.5.2. The stress-strain model and mental workload

Wickens et al (2013) remark that whether an internal or external stressor is under study, the effects of that stressor on performance and MWL are often explained in relation to arousal theory (e.g. Selye, 1976). Arousal refers to a person's level of activity observed either through behavioural states (wakefulness) or subjective experiences (e.g. drowsiness) (Wickens, et al., 2013). Stress is thought to improve performance when levels of arousal are low, through mobilisation of cognitive resources and effort. As arousal and stress levels increase individuals will show performance increments up to a certain level of arousal, past this level, performance declines. This is known as the Yerkes Dodson law (1908) (Wickens, et al., 2013). An alternative view is the transactional view of stress (Lazarus & Folkman, 1987) which places importance on the individual's appraisal of the stressor (e.g. is it threatening to performance or not) and whether they feel they have the ability to cope with this stressor (Wickens, et al., 2013).

Table 2.2: Definitions of MWL from the literature

"Mental workload describes the relation between the (quantitative) demand" (Wickens, 2002; pp.161)
"Mental workload characterizes the demands of tasks imposed on the limited information processing capacity of the brain in much the same way that physical workload characterizes the energy demands upon the muscles" **(Wickens, et al., 2013; p.347)**
"While demand relates to the load imposed on people, the load experienced may be a better indicator of workload in the sense that it reflects the human information processing that actually occurs, rather than what was required by the task. Use of information processing resources may be indicative of capacity utilized and, by inference, capacity remaining for performing other tasks." (Rouse, Edwards, & Hammer, 1993; p. 1662)
"Mental workload is recognized as a multi-dimensional construct that is largely driven by the characteristics of local task demands. It has been linked in some fashion to many major theories of human cognition, such as the automatic-versus controlled-processing position and [...] attentional resource constructs, as well as other models of the human operator, such as those founded in control theory. [...] The present conceptualization of workload is conceived in three dimensions: effective time for action, perceived distance from the desired goal state, and level of effort required to achieve the desired goal." **(Hancock & Caird, 1993; p. 413-4)**
"(1) Put most simply, mental workload is the amount of mental work or effort necessary for a person or group to complete a task over a given period of time. (2) Mental workload cannot be detected directly, but through the measurement of some other variables that are thought to correlate highly with it, such as subjective rating, performance and some physiological data. (3) Mental workload has both static and dynamic attributes, which reflect, respectively, the mental workload within a time interval and at a single moment. (4) Each individual has limited processing capacity or processing resources. Mental workload involves the depletion of internal resources to accomplish the work. High workload depletes these resources faster than low workload. The requirements for resources can be unbalanced when performing a task. Some sources may remain underloaded while other sources are overloaded...(6) Mental workload can be affected by many factors. It is not merely a property of the task, but also of the individual, and their interaction." (Xie & Salvendy, 2000; p. 76-7)
"Current theory rightly emphasizes the interactive or transactional nature of mental workload. This means that it is a product of the interplay between the (objective) demands of the task and the skill and ability of the individual, as well as the environmental and motivational context in which the work is carried out. Therefore checking a set of accounts or monitoring a radar display may be perceived as demanding or not, depending on the employee's skill, effort capacity and motivational level, his or her level of training and familiarity with the work, tolerance of ambient environmental conditions (noise, heat, etc.), and so on." (Hockey, 2002; p. 33-4)

Table 2.2 (continued): Definitions of MWL from the literature

"Mental workload: the demands placed on information processing capacities by tasks that a person is to perform." (Proctor & Vu, 2010; p.625)

"We conducted a meta-analysis focusing broadly on the effects of cognitive load on human duration judgments. A critical feature of it is the specification of the meaning of the term cognitive load and how it is used in the literature. We define cognitive load as the amount of information-processing (especially attentional or working-memory) demands during a specified time period; that is, the amount of mental effort demanded by a primary task. These demands may also include some heavily cognitively driven perceptual-motor processes." (Block, et al., 2010; p.331)

"It has become the accepted position that mental workload is a multidimensional and mediational construct that can provide important insight into response capability" (Hancock, Williams, & Manning, 1995; p. 64)

"Surprisingly, there is no universally accepted definition of mental workload: a consensus exists merely to define it as the "cost" of a given task for the operator. Concept of mental load is related to information processing theory. Limited capacity of cognitive resources and sequential processing of information define what can be *overload*: an excessive demand on perceptual and cognitive resources (visual and auditory perception, memory and attention, among others) with respect to information processing capacities."
(Averty, Athenes, Collet, & Dittmar, 2002; p. 7.1.4-1)

"Mental workload can be defined as the cognitive demand of a task." (Galy, Cariou, & Mélan, 2012; p.269)

"Workload is defined as the investment of cognitive resources induced by task demands." (Matthews et al., 2002; p. 323)

"The term workload is used to describe aspects of the interaction between an operator and an assigned task. Tasks are specified in terms of their structural properties; a set of stimuli and responses are specified with a set of rules that map responses to stimuli. There are, in addition, expectations regarding the quality of the performance, which derive from knowledge of the relation between the structure of the task and the nature of human capacities and skills. Frequently, these expectations are not met even though the individual is motivated to accept the assignment and intends to perform according to expectations. ..[W]orkload is invoked to account for those aspects of the interaction between a person and a task that cause task demands to exceed the person's capacity to deliver. .. [M]ental workload is clearly an attribute of the information processing and control systems that mediate between stimuli rules, and responses." (Gopher & Donchin, 1986; p. 41-3)

Matthews et al (2002; 2006) developed a self-report tool called the Dundee Stress State Questionnaire (DSSQ) to measure individual's cognitive appraisals before and after a task in order to measure stress responses. This battery of questionnaires was also designed to tap effects of stress at the physiological and information processing levels (Matthews, et al., 2002; Matthews, et al., 2006; Wickens, et al., 2013). Hockey (1997) hypothesised that different control modes which related to self-regulatory behaviours under varying task demands could be observed through characteristic patterns of behaviour, physiological responses and subjective state reports. For example when an individual was experiencing overload they would show reduced performance on low priority task items or a secondary task, adrenaline excretion and increased strain (Hockey termed this the overload mode; Hockey, 1997; Matthews, et al., 2002). The DSSQ attempts to measure the subjective states relating to Hockey's modes of control (Matthews, et al., 2002). The DSSQ also includes a slightly modified version of the National Aeronautics and Space Administration task load index (NASA-TLX) which is a self-report measure of MWL (Matthews, et al., 2002). Before looking at other factors relating to the CSM, two other concepts which are closely related to MWL; cognitive load and situation awareness are discussed in the next sections.

2.5.3. Mental workload and cognitive load

One term sometimes used interchangeably with MWL is cognitive load. This study uses the term MWL because cognitive load theory (CLT: Paas, Tuovinen, Tabbers, & Van Gerven, 2003; Paas & Van Merrienboer, 1994; Paas & Van Merrienboer, 1993) is a distinct theoretical construct developed within the field of educational psychology, which MWL relates to, but is by its definition quite different.

CLT is concerned with how individuals learn novel tasks, in particular complex tasks which require all the learner's cognitive resources to carry out the task (intrinsic load) leaving no mental capacity to discern the rules of the task (extraneous load), or rehearsing, encoding and assigning information about the task to LTM (germane load) (Hutchins, Wickens, Carolan, & Cumming, in press). There are three categories of cognitive

load that Paas et al (2003) identify these are intrinsic, germane and extraneous cognitive load. *Intrinsic cognitive load* refers to the demands the (interacting) task elements make on WM capacity (Paas, et al., 2003). Therefore intrinsic cognitive load is closely related to the MWL of a task (Wickens, et al., 2013). *Extraneous cognitive load* refers to the load that is caused by how people are taught a task (the instructional procedures) as sometimes knowledge and skills can be taught in a way that is not easily accessible to the novice. Extraneous cognitive load is seen as inhibiting learning because it is additional load that can be lessened through careful planning of the way new tasks, skills and knowledge are taught. *Germane cognitive load* is the amount of mental resources required to encode, rehearse and assign knowledge and skills to LTM. These three types of cognitive load are additive and the three types of load cannot exceed WM capacity if learning is to occur (Paas, et al., 2003).

MWL differs from CLT because, as can be seen from the discussion above regarding the definitions of MWL, the common consensus is that MWL relates to the subjective experiences of WL caused by reaching the capacity limits of WM but also limits of attentional resources. CLT only specifically refers to the load placed on WM and LTM processes, although informally notes the role of attention in learning but not its capacity limits (Paas, et al., 2003). Both MWL and CLT account for the differences between expert and novice performers of a task, highlighting the role of LTM and the benefits it provides in terms of reducing the load of performing a task. This reduction occurs because WM does not have to hold all this information once it is stored in LTM. Many definitions of MWL also refer to the motivational level of the individual learning or carrying out a task, other subjective states they may be experiencing and the environment in which the task is carried out, which CLT does not. MWL is therefore considered for this study as a more holistic definition of the load that individuals experience when they carry out a task.

Traditionally CLT has been used in human factors research and interventions to provide a framework to maximise the effectiveness of the delivery of training and instructional manuals for new systems, technology

and software (Hutchins, et al., in press) and is also now being applied to healthcare (Van Merriënboer & Sweller, 2010). Recent research (Averty, et al., 2002) has related measures of MWL to measures of cognitive load. Averty et al (2002) found that CLT was a useful framework for evaluating the load placed on employee's WM processes, but only when measures of participants' alertness were taken into account, as germane load varied significantly with levels of arousal. This research underlines the importance of considering the alertness and other subjective states of employees when considering solutions designed to reduce safety incidents.

2.5.4. Mental workload and situation awareness (SA)

Another concept, not yet discussed but is as widely used as MWL is situation awareness (SA) (Tsang & Vidulich, 2006). At its most basic level SA refers to peoples' perception of what is happening around them and in their environment at any one moment in time (Endsley, 1995). SA has become a widely used concept since the 1990s (Tsang & Vidulich, 2006) and can be broadly defined as *"the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and their projection of their status in the near future"* (Endsley, 1995; p.36). Endsley (1995) explains that within this definition there are three levels which need to be achieved for a person to be situationally aware. Level 1 requires the accurate perception of the status, attributes and dynamics of the elements within the environment. For example a CP may perceive how organised the dispensary currently is, what the rest of the team are doing in order to complete dispensing work, how over the counter (OTC) medication sales are going and the advice been given by medicine counter assistants, how many people are waiting to be seen, if there are any patients who could benefit from an MUR. Having perceived all the activity currently going on the next level of SA the pharmacist must achieve is the formation of a coherent appraisal of the status of the system as a whole. This occurs through reviewing all these elements simultaneously in relation to the goals needing to be met (e.g. dispensing work to complete, MUR consultations to carry out). In order to reach the final level of SA the CP must be able to predict the (near) future actions of

the elements in the environment in order that goals can be readily achieved. Projection of future actions of the elements is achieved through knowledge of the status and dynamics of the elements and comprehension of their meaning (both level 1 and 2 SA). For example at certain times of the day CPs will expect a stock delivery, collection of the medicines to be delivered to patients by drivers, and an increased volume of patients (e.g. over lunch time when people leave work to go to the pharmacy to pick up their medicine in their lunch break). When SA is lost, errors or safety incidents can occur, for example in a pharmacy, patients medication may not be dispensed because the prescription was missed, or the patient is given the wrong medicine because medicines and medicine labels were paired incorrectly.

Some researchers have questioned whether MWL and SA are truly distinct concepts, given that they both draw upon and are undermined by the capacity limits of WM and attentional processes (Tsang & Vidulich, 2006). Hendy (1995) argues that these concepts are distinct but closely related, so much so that designing SA measures which do not tap aspects of MWL has been difficult. Tsang and Vidulich (2006) outlined a theoretical framework which illustrates the relationship between MWL and SA (see Figure 2.5 below). As can be seen from the definition given by Endsley (1995) above, SA is about perception of all elements of the environment and predicting how events may unfold in the near future. In order to maintain SA, the task(s) at hand must not overload WM or attention processes otherwise SA will be lost due to an inability to perceive all environment elements. SA has been a useful concept for high pressure situations which entail disastrous consequences if SA is lost, e.g. during surgical procedures (McIlvane, 2007).
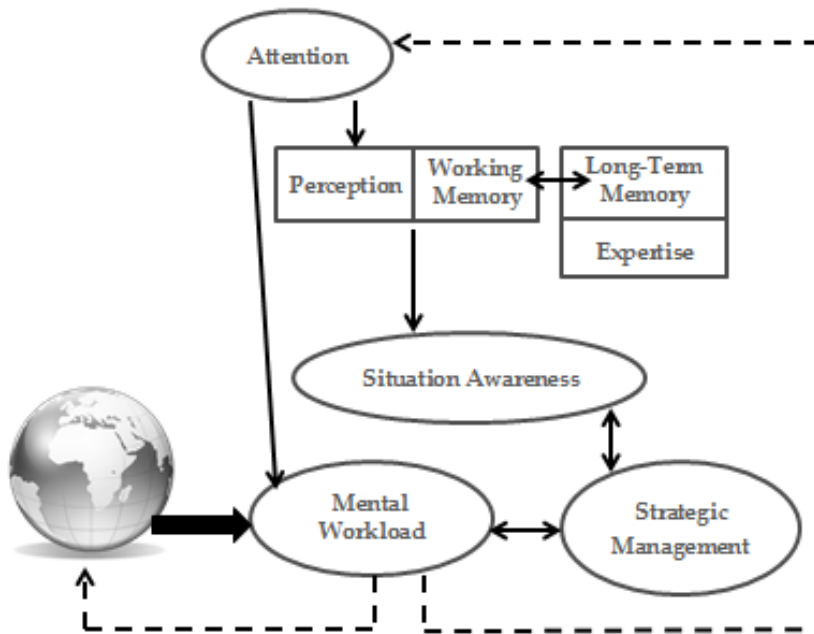
Figure 2.5. Theoretical framework of the relationship between mental workload and situation awareness (from Tsang & Vidulich, 2006, with permission)

2.5.5. Measuring mental workload

Performance on the primary task is a direct measure of MWL. However, in order to accurately measure the MWL involved in a task (the primary task) it is not sufficient to simply measure primary task performance (e.g. accuracy checking performance) as people can invest more effort to compensate when internal or external stressors threaten performance (Hockey, 2002). There are also many reasons why performance may vary on a task that is unrelated to MWL (for example signal probability can affect accuracy checking performance, this is discussed in section 2.7.1 below). Therefore, when considering the MWL involved in a task, primary task performance is usually considered along with a second measure of MWL (Hockey, 2002).

There are many methods used to measure MWL, these include self-report questionnaires, secondary task performance and psychophysiological measures (Hockey, 2002; Wickens, et al., 2013). When deciding how to measure MWL three issues need to be considered. First, how sensitive a

method is to changes in MWL. Methods also vary in their level of diagnosticity of the causes of MWL and how this relates to stages of information processing. Finally, some methods interfere with task performance more than others (as they require additional actions from the individual carrying out the primary task) (Hockey, 2002). The different methods are considered below in terms of the level of sensitivity, diagnosticity and intrusiveness of each method.

Secondary task performance

In order to identify how much information processing capacity the primary task uses participants are often asked to carry out a concurrent secondary task. The assumption underlying this method is that the information processing capacity not being used to carry out the primary task can be used to perform the secondary task. Performance on the secondary task is therefore used as a measure of how much capacity is being used by the primary task (Hockey, 2002). There are many different types of secondary task, these include secondary task probes, for example responding to events (e.g. the sounding of a tone through headphones or in the environment) whilst carrying out the primary task. A loading task can also be used which participants are asked to give priority to instead of the primary task. A less intrusive secondary task is an embedded task (e.g. a measure of how often a driver checks rear-view and wing mirrors during a driving task) (Hockey, 2002; Wickens, et al., 2013). All types of secondary tasks have one methodological problem, the experimenter has no control over how much attention is given to the primary or secondary task, and a participant may chose to ignore the secondary task altogether in high demand settings (Wickens, et al., 2013). This issue limits the sensitivity of these measures to changes in MWL.

Self-report measures

Self-report measures are the most popular measures of MWL due to their ease of use, limited intrusiveness on the primary task and sensitivity to small changes in MWL. There are unidimensional and multidimensional measures of MWL. The NASA-TLX is the most widely used self-report measure (Hart & Staveland, 1988). It is a multi-dimensional measure of

MWL which means it can distinguish between tasks which are mentally demanding compared to those which add time pressure or physical load (Wickens, et al., 2013). Self-report measures can only capture retrospective reports of MWL and information that is available to consciousness so provide less diagnosticity than other methods (Wickens, et al., 2013).

Psychophysiological measures

There are many psychophysiological measures of MWL, these include autonomic (heart rate variability, pupil dilation), electrophysiological (electroencephalogram and event related potential measures) and haemodynamic (functional magnetic resonance imaging, ultrasound and near infrared spectroscopy). These methods provide diagnostic information and can measure MWL as they vary throughout a task (Wickens, et al., 2013). The electroencephalogram (EEG) measure is sensitive to WM resource demands. The EEG data can then be summarised to provide event related potential (ERP) indexes. One ERP component called the P300 (this is a positive ERP wave) has been shown to increase in latency when targets in a visual search are difficult to detect providing an index of attentional demand (Parasuraman, 2013; Wickens, et al., 2013). Whilst EEG measures do not interfere with performance of a task, they can be uncomfortable for participants to wear and the data can contain a large amount of noise from eye and muscular movements (Wickens, et al., 2013). Heart rate and pupil dilation have been found to change in response to mental challenge and these physiological markers can be slightly easier to measure compared to EEG. Ultrasound and near-infrared spectroscopy measure changes in oxygenated blood levels and blood flow and have been used to index MWL levels. These levels increase when information processing demands increase (Wickens, et al., 2013).

When deciding how to measure MWL, the psychophysiological methods provide the most detailed measure of MWL. However, this data is harder to collect in naturalistic settings as it often requires participants to be in a fixed position (Wickens, et al., 2013). This equipment is also more costly than freely available self-report tools like the NASA-TLX or secondary task measures. It is also important to note when choosing a method that these

different types of measures may not agree in every context, an example of this is secondary task measures and self-report measures may dissociate due to the mental effort of carrying out two tasks at the same time will lead to increased reports of MWL. However in this instance multidimensional scales overcome this issue to some extent (Wickens, et al., 2013).

2.5.6. Mental workload and accuracy checking performance

Having looked the MWL and the related concepts of SA and cognitive load in detail, this next section considers the relationship between MWL and accuracy checking performance. Very little research has been carried out into the MWL involved in pharmacy tasks, less still into the relationship between MWL and accuracy checking performance. However, one study into this issue has been conducted by Reilley, Grasha and Schafer (2002). In this study two groups of participants carried out an accuracy checking task. One group of participants were asked to check 72 simulated medicines in 120 minutes, the other group were asked to check 120 simulated medicines in 120 minutes (Reilley, et al., 2002). During the study participants were asked to report their MWL at several time points using the NASA-TLX measure (a widely used self-report measure of MWL). No significant difference was found in the reports of MWL between the two groups. However the participants who checked 120 items in 120 minutes missed significantly more DEs (Reilley, et al., 2002). The findings in relation to MWL may be limited as the participants in this study were undergraduate psychology students and they checked simulated medicines made from bottles of nuts and bolts. As these participants had no experience of this task, their MWL could have been high due to the novelty of the task and their efforts to learn the most effective way to carry out the task. It is therefore unknown whether pharmacy students and CPs would report similar levels of MWL under the same conditions.

2.6.   The Human factor

So far this review has outlined models of human cognition, MWL and theories of optimal and sub-optimal performance of cognitive processes. This will be followed by a brief overview of the field of human factors which emerged from research into human error. The impact that human factors experts have made towards improving the safety of healthcare to date is also discussed.

2.6.1. Human error

Human error has been estimated to be the primary contributor of between 40-90% of major incidents and accidents in complex systems (e.g. nuclear power, aviation) (Hockey, 2002; Spettell & Liebert, 1986; Wickens, et al., 2013). Highly automated systems have been produced in these fields since these estimates were made reducing the involvement of pilots and nuclear power station operators in the safety critical tasks which were found to be susceptible to human error.

In healthcare some disciplines employ similar levels of automated systems to those seen in aviation, nuclear power (e.g. anaesthetists, radiologists) whereas other disciplines (e.g. surgeons, nurses) do not (Reason, 2004). This suggests that human error is an even larger issue for many aspects of healthcare where automated controls are not widely used. Pharmacy sits between these two extremes, within hospital pharmacy there has been a greater uptake of automated dispensing systems (Angelo, Christensen, & Ferreri, 2005; Franklin, et al., 2008; James, Barlow, Bithell, Hiom, Lord, Oakley, et al., 2013; James, Barlow, Bithell, Hiom, Lord, Pollard, et al., 2013; Lin, Huang, Punches, & Chen, 2007) but these systems due to their size and cost have not been employed widely within a community pharmacy setting (James, et al., 2009). This means that many of the safety critical tasks are carried out by the pharmacist or a member of their team and these tasks are therefore susceptible to human error.

Human error or systems error?

When an error is made, it is not always obvious why or how that error has happened. Reason (2000) discusses the two approaches to understanding

human error that currently exist within organisations: the person approach and the system approach. The person approach assumes that unsafe acts, errors and procedural violations of professionals at the sharp end: nurses, doctors, pharmacists, are due to failures by them to pay enough attention, remember or maintain high standards of ethics. The system approach studies the conditions under which individuals work (e.g. "upstream systemic factors like organisational processes) and tries to build defences within the system to prevent errors or mitigate their effects (Reason, 2000). Many researchers have advocated a systems approach to medication errors, for example Cohen (M. R. Cohen, 2007) writes *"finding out who was involved is less important than learning what went wrong, how and why"* (p.55). However, Grasha (2002a) argues that a systems approach to errors overlooks how the elements of systems are integrated into employee's subjective experiences and thoughts about work. Grasha considers these effects as important, because peoples' beliefs, attitudes and feelings about events that occur both in and outside of the workplace will combine to have an effect on work performance. For example, through creating a source of tension or mental distraction (Grasha, 2002a).

Currently, the culture within healthcare in general does not take a systems approach, tending towards a person approach to human error instead (Reason, 2000). Although the approach can vary between different areas of healthcare. For example, research and interventions targeting the systems that operating theatre teams use (and the way they work together) are now being trialled to improve patient safety (van Beuzekom, Boer, Akerboom, & Hudson, 2012). Reason suggests that the focus to date on the person approach may be due to the ease and satisfaction of identifying individuals to blame. He also explains that the major disadvantage of the person approach to errors is that we cannot change people and their limitations, but we can change the conditions under which people work (Reason, 2000).

Perhaps the most famous and influential model of human error and safety, is Reason's Swiss cheese model which illustrates the importance of taking a systems approach to safety (see Figure 2.6 below). Each piece of the

Swiss cheese is a defensive layer (barrier or safeguard). An example of a defensive layer is an alarm, a physical barrier or automatic shutdown in a highly engineered system. In healthcare, an example defensive layer may be allergy warning bands or bracelets warning of chronic conditions (e.g. diabetes) should a person become ill. Reason states that these defences whilst very effective are in reality like slices of Swiss cheese and have many holes, whilst a hole in one slice is not an issue, sometimes holes in slices may line up to produce an opportunity for an accident or error (Reason, 2000).
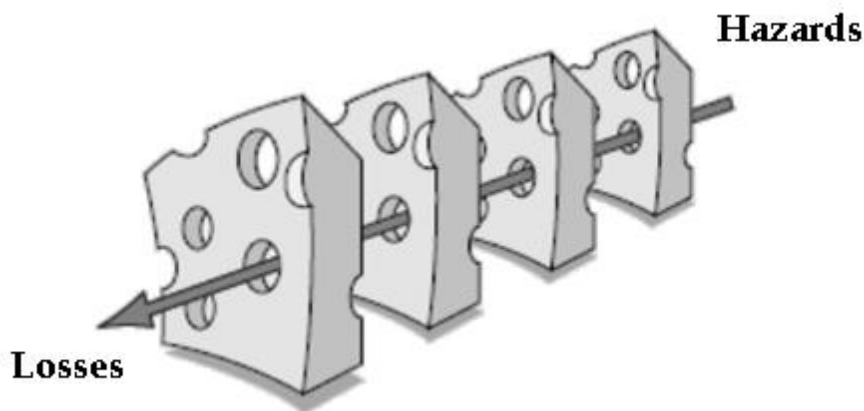
Figure 2.6. The Swiss cheese model of how defences, barriers and safeguards may be breached by an accident trajectory (from Reason, 2000, pg 769, with permission)

The causes of the holes in the Swiss cheese are latent and active failures. Active failures are unsafe acts committed by people at the sharp end (e.g. nurses, pharmacists) who are in direct contact with the patient, and they can take a variety of forms, slips, lapses or mistakes. Latent conditions are strategic decisions, e.g. in the design of tasks, policies and procedures, or simply the working environment. Latent conditions can trigger error provoking conditions for example time pressure, understaffing, unsatisfactory equipment and inexperience (or overreliance on members of staff who are inexperienced). Latent conditions are easier to identify than active failures and therefore can be rectified before an accident or error occurs (Reason, 2000). CP WL is one latent condition that has been discussed and researched in detail. However as discussed in this chapter 1, it is difficult to define, and identify what levels of WL present as latent

conditions as underload can be just as dangerous as overload. Some research has already been carried out into the latent and active failures that may occur in pharmacies, this is now discussed below.

A systems approach to pharmacy errors

Leape et al (1995) analysed 334 medication errors[4] and 264 preventable medication errors collected over a 6 month period across two US hospitals. This study identified 13 proximal causes (the reason why the error was made) similar to the active failures defined in Reason's model and 16 underlying systems problems that might cause medication errors (similar to latent conditions) (M. R. Cohen, 2007; Reason, 2000). Seven systems failures were found to account for 78% of the errors identified in this study (Leape, et al., 1995). The proximal causes and systems failures are identified in Tables 2.3 and 2.4 below. When hospital pharmacists made or missed errors it was often related to look-a-like or sound-a-like drug names and packaging (see Table 2.3 below). Other systems issues that were identified as reducing the safety of pharmacists work were patient information availability, inter-service communication (between doctors, nurses and pharmacists), staffing levels and conflict resolution (where pharmacists and nurses felt unable to challenge an error made by a doctor, or were unsure how to manage the conflict that arose when they did) (Leape, et al., 1995).

In community pharmacy settings CPs have little-to-no access to detailed patient records, so often are dispensing medicines without the level of information that hospital pharmacists have access to. They also often have less ready access to the individuals (e.g. general practitioners) who have prescribed the medicine should there be a problem (although some community pharmacies are co-located with general practices).

---

[4] Termed adverse drug events in this study, and included dispensing errors, drug administration errors, prescribing errors and transcription errors.

Table 2.3. *Systems failures relating to the occurrence of medication errors (Leape, et al., 1995)*

Drug knowledge dissemination
Dose and identify checking
Patient information availability
Order transcription
Allergy defence
Medication order tracking
Inter-service communication
Device use
Standardisation of doses and frequencies
Standardisation of drug distribution within unit
Standardisation of procedures
Preparation of intravenous medications by nurses
Transfers / transition procedures
Conflict resolution
Staffing and work assignments
Feedback about medication errors

Note: cells shaded in grey relate to system failures that led to medication errors being missed or made by hospital pharmacists

Table 2.4: Proximal causes of medication errors (Leape, et al., 1995)

Lack of knowledge of the drug
Lack of information about the patient
Rule violations
Slips and Memory lapses
Transcription errors
Faulty drug identity checking
Faulty interaction with other services
Faulty dose checking
Infusion pump and parental delivery problems
Inadequate monitoring
Drug stocking and delivery problems
Preparation errors
Lack of standardisation

Note: cells shaded in grey relate to causes of medication errors missed or made by hospital pharmacists

Taxonomies of human error

Reason (1990) and other key researchers in the human error field e.g. Rasmussen (1982), Norman (1981) have produced taxonomies of human error. These classification systems are used both retrospectively, to explain incidents that have happened, and proactively to predict errors that might occur (Stanton & Salmon, 2009). Sharit (2006) comments that within the healthcare industry, the diversity of clinical procedures and the variety of professions each with their own (differing) approach to healthcare and

illness, means that highly specific error taxonomies would need to be developed. There are many general error taxonomies as well as specific ones, three of the most influential taxonomies, chosen as they provide an overview of how the field of human error has developed, are now discussed.

Norman's taxonomy

Norman analysed 1000 action slips including the flight errors reported by Fitts and Jones (1947) and others in order to understand the cognitive processes underlying our everyday tasks (Norman, 1981). The use of error data to inform models of cognition have been criticised in the past as they reflect systems when they fail not when they work correctly. However, Norman has argued that models of cognition should be able to account for the correct performance of day to day tasks, but also the times, albeit rare times, when these tasks are carried out incorrectly (Norman, 1981; Reason, 1990). Norman was particularly interested in action slips which are defined as a form of human error where an action that was not intended is performed (Norman, 1981). People make action slips every day for example, pouring tea into the sugar bowl, or taking your normal route home when you meant to go somewhere else (Styles, 2006).

Based on his database of action slips, Norman defined three main sources of action slips, the formation of the intention, activation, and triggering (Norman, 1981) (see Table 2.5 below). The action slip data also formed the basis of his theory, the Activation-Trigger-Schema System, and the model of Attentional Control described in section 2.4.4 (Norman, 1981; Norman & Shallice, 1986). Norman's Activation-Trigger-Schema System theory proposed that hierarchical knowledge structures called schema (organised memory units or mental models) are activated which trigger action sequences. Multiple schema can be activated at any one time if particular conditions are satisfied (or events occur). It is important to note that Norman's taxonomy of human error is restricted to the errors that occur when we try to carry out an intended action but an unintended action occurs (Norman, 1981; Reason, 1990; Stanton & Salmon, 2009).

Table 2.5: Norman's taxonomy of action slips (Norman, 1981; Reason, 1990; Stanton & Salmon, 2009)

Category of error	Types of error under each category	
Slips that result from errors in the formation of the intention	Mode errors	Incorrect classification of the situation. Mode errors usually relate to interactions with technology and incorrectly identifying what mode the technology is in.
(misinterpretation of the situation)	Description errors	Ambiguous specification of the intention
		Incomplete specification of the intention
Slips that due to faulty activation of schema	Unintentional Activation	Capture errors: when similar sequences of action are present but a better learned or more frequent sequence captures control erroneously
(occurring because of similar trigger situations)	*(When schemas not part of a current action sequence become activated for extraneous reasons, then become triggered and lead to slips)*	Data-driven activation errors: when external events cause activation of schemas
		Association-activation errors: currently active schemas activate other schemas they are associated with
	Loss of activation:	Forgetting an intention (but continuing with the action sequence)
	(Where schemas that have been activated lose activation thereby losing control over behaviour)	Misordering the components of an action sequence
		Skipping steps in an action sequence
		Repeating steps in an action sequence
Slips that occur because of faulty triggering of schema	False Triggering	Spoonerisms: reversal of event components
	(A properly activated schema is triggered a the wrong time)	Blends: combinations of components from two competing schema
(i.e. too early or too late)		Thoughts leading to actions: triggering of schemas meant only to be thought not control action
		Premature triggering
	Failure to trigger	Action pre-empted by competing schema
		Insufficient activation: either as a result of forgetting or because initial activation levels were too low
		Failure of the trigger condition to match e.g. because the triggering conditions were badly specified

The Activation-Trigger-Schema System theory allows many opportunities for slips, as Table 2.5 above shows there are three main ways in which slips can occur: during the formation of an intention, through faulty activation of schema or faulty triggering of schema, for example, too early or too late in the action sequence (Norman, 1981; Stanton & Salmon, 2009). In a community pharmacy there are many opportunities for the wrong or many schema to be activated at the same time, for example a commonly prescribed and dispensed medicine that has many strengths and formulations, may activate many children schema (the lower level schemas) and they then could compete for control over action. Alternatively a medicine may look like several others (as packaging of different medicines can be very similar) (M. R. Cohen, 2007) and so a schema relating to the look of the medicine could incorrectly trigger the action to select the wrong medicine.

Rasmussen's taxonomy of errors

Rasmussen also produced a taxonomy of errors in his paper on the modelling of cognitive control processes (Rasmussen, 1982). Rasmussen's model, unlike Norman's model which described the typically minor action slips of everyday life, attempts to explain errors made by individuals in control of industrial systems and emergencies that occurred in hazardous process plants (Rasmussen, 1982; Reason, 1990). This taxonomy was developed based upon a verbal protocol study of technicians involved in electrical trouble-shooting (Rasmussen, 1982; Reason, 2000). This taxonomy recognises that errors are affected by skill, experience and familiarity with the situation or context the error occurs in (Rasmussen, 1982; Stanton & Salmon, 2009). Therefore, novice pharmacists (or pharmacy students undergoing training) would not be expected to make the same errors as expert pharmacists (those who have qualified and worked in practice).

Rasmussen identifies three typical levels of performance, skill-based, rule-based and knowledge-based behaviour (see Figure 2.7). At the skill based level, when an intention is formed sensorimotor performance occurs without conscious control, as smooth, automated and highly integrated patterns of behaviour (Rasmussen, 1983). Sub-conscious routines and

stored patterns of behaviour control performance in a time-space domain (Rasmussen, 1982). Performance of tasks at this level requires a very efficient and dynamic internal model (or set of schemas) and feed-forward control (e.g. reading ahead in music whilst still playing the previous bars) (Rasmussen, 1983). Errors at this level are related to the variability of space, force or time coordination (Rasmussen, 1982, 1983). As this level, task performance occurs without conscious control as perception leads straight to the activation of schemas for action in LTM bypassing WM (Sharit, 2006).

Performance carried out at a rule-based level is based upon subconscious sub-routines for familiar tasks and stored rules for the coordination of these sub-routines. This level of processing makes some demands on WM as rules formed from previous experience are assessed to see how well they map onto the current situation. An existing rule may be chosen, but it may need to be modified if issues occur during the application of the rule. Therefore WM and attentional resources are still used in order to monitor whether the chosen rule is appropriate (Sharit, 2006). Errors at this level are typically related to misclassification or recognition of the situation (having not yet experienced all alternatives of a situation or task, or over-generalising a rule to an inappropriate situation) (Rasmussen, 1982; Reason, 1990; Stanton & Salmon, 2009). Alternatively at this level memory slips and selection of the wrong procedures can occur and lead to errors (Rasmussen, 1982). This may be a scenario experienced by pharmacy students as they enter their pre-registration post following completion of their degree, or during a work experience post during their degree. In the first few weeks of a pre-registration or work experience post, novice pharmacists will apply the subroutines gained in practice at university and when these subroutines fail, expand, build and adapt these as they make errors dispensing medicinal products they haven't seen before (e.g. failing to put on extra warnings or monitoring cards in with a medication for a patient).

The final level is a knowledge-based approach to tasks. Individuals work at the knowledge-based level when they are required to work in

unfamiliar situations or carry out an unfamiliar task. At this level the person must decide how to proceed based on an analysis of the context, the task goals, and physical and functional properties of the task and the system within which they are working (i.e. organisational climate – "this is how we do things around here") (Rasmussen, 1982; Reason, 1990; Stanton & Salmon, 2009). This level relies heavily on WM, attention and LTM processes. Errors at this level are difficult to predict and study as they are based on many variables individual to the person carrying out the task (Rasmussen, 1983).

Sharit (2006) notes that in complex tasks or situations individuals with a large amount of expertise will probably work at all three levels at the same time, as different components of a task may require all three types of processing. A good example is driving, where experienced drivers will carry out routine gear changes, breaking, accelerating without conscious control, however, when driving somewhere new, information processing at knowledge and rule based levels will also occur (Stanton & Salmon, 2009).

This model of cognitive control is intended to represent the level of skill present in the individual for that task and has implications for the attentional and memory demands of the task (Stanton & Salmon, 2009). For example, complex tasks like driving, action can be directed at all three levels simultaneously (Stanton & Salmon, 2009). With pharmacy dispensing, different stages of the process may be carried out at different levels e.g. clinical and legal checks may be knowledge-based but product selection and preparation will likely be skilled-based for a pharmacist or member of the dispensing team who has been working in that dispensary for a while. Based on the three levels of task performance, Rasmussen proposed a taxonomy of the types of errors which might occur which are summarised in Table 2.6 below.
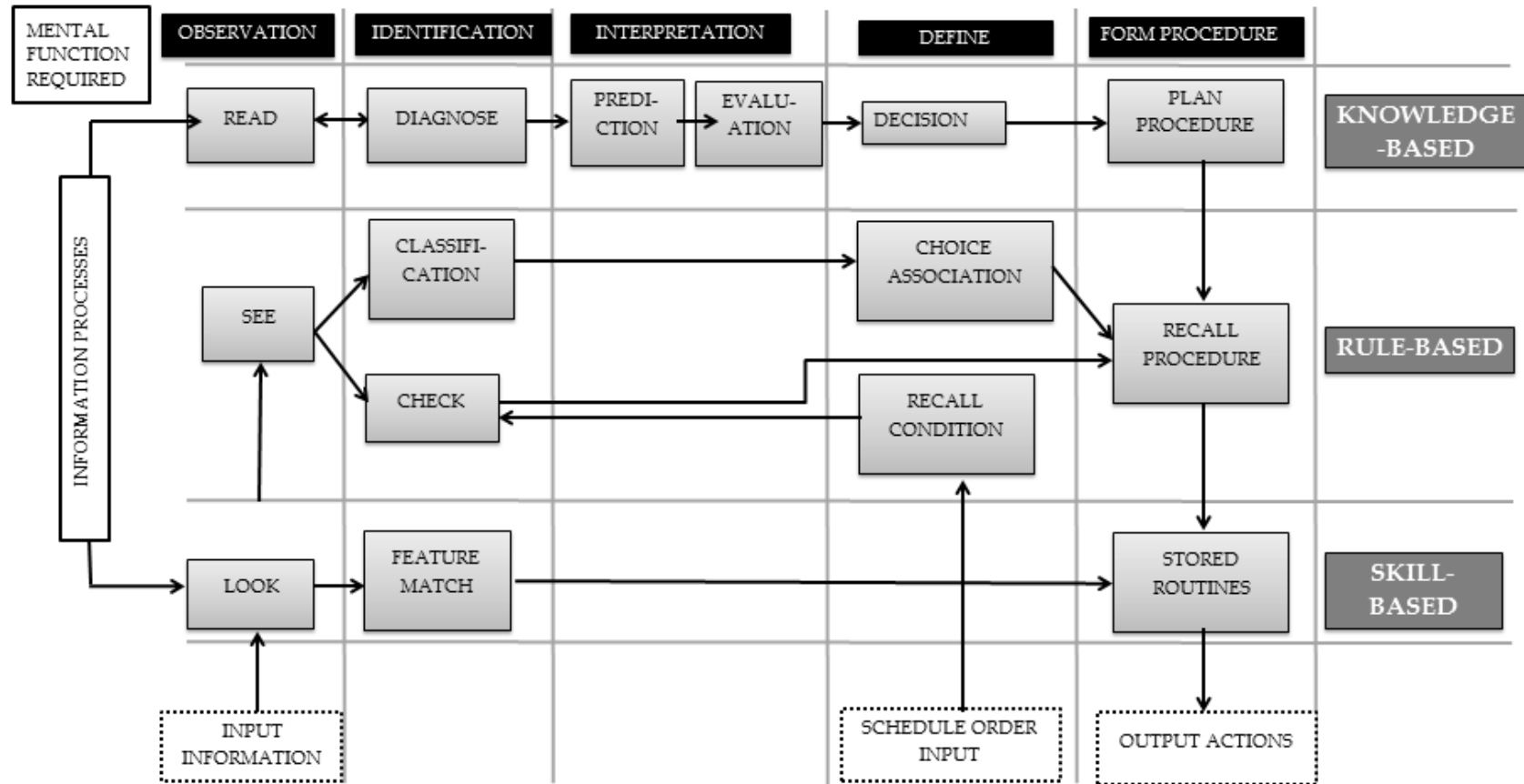
Figure 2.7. Rasmussen's Skill, Rule, Knowledge based model of behaviour (from Rasmussen, 1982, pg 317, with permission). *This diagram illustrates how the same behaviour can be served by different information processes, each process carries its own risk of error.*

Table 2.6: Rasmussen's taxonomy of errors (Rasmussen & Vicente, 1989)

	Effects of learning and adaptation	Interference among competing control	Lack of resources	Stochastic variability
Knowledge-based errors	Search for information and test hypotheses in novel situations may lead to acts which are judged as errors after the fact.	False analogies (e.g. similarity matching bias / confirmation bias (Reason, 1988) causing interference between schema	Limitations of linear reasoning in causal networks; insufficient knowledge, time, force, etc.	Slips of memory in mental models.
Rule-based errors	The law of least effort may lead to underspecified cues.	Functional fixation; adherence to familiar rules.	Inadequate memory for rules.	Erroneous recall of data or parameters related to rules.
Skill-based errors	Optimisation of motor skill needs feedback from boundaries of acceptable performance (speed-accuracy trade-off).	Capture by frequently used motor schema.	Lack of speed, precision, force.	Variability of attention; variability of motor parameters, motor noise (variation in force, precision of movements).

Rasmussen also identified eight stages of decision making: activation, observation, identification, interpretation, evaluation, goal selection, procedure selection and activation (Reason, 1990) which can be seen in Figure 2.7 above. Reason (1990) comments that Rasmussen's greatest contribution to this area was charting how decision making or problem solving occurs, and in particular how this is not necessarily a linear process and many stages can be skipped as one gains more expertise in this area (Rasmussen, 1982, 1983; Reason, 1990)

Reason's taxonomy of errors
Reason's taxonomy of errors (see Table 2.7) combine's the theories of both Norman (1981) and Rasmussen (1982) in order to explain errors that might

occur at the level of everyday action slips and during complex tasks where individuals have varying levels of expertise (Reason, 1990). Reason outlines three basic error types: skill-based slips and lapses, rule-based mistakes and knowledge-based mistakes. Lapses are like slips in the sense that they are errors which result from the failure in either the execution or storage stage of an action sequence (Norman, 1981; Reason, 1990), but are less obvious than slips. For example a slip may be a slip of the tongue, whereas a lapse may be a failure of memory. Lapses therefore may not manifest themselves in actual behaviour and may only be noticeable to the individual who experiences them (Reason, 1990). Mistakes are failures in judgemental or inferential processes that select or specify the action to be carried out. Mistakes can often go unnoticed by the individual carrying out the task. Unlike slips and lapses, individuals are not often aware of when their judgement or decision making has failed (Reason, 1990). Slips and lapses are examples of errors where the action carried out was unintended, whereas mistakes are examples of errors where the action carried out was intended (Stanton & Salmon, 2009). Reason (1990) suggests that slips and lapses occur because of inattention or too much attention being focussed on the task (e.g. monitoring performance at the wrong points of the task) (Stanton & Salmon, 2009). Whereas mistakes are more likely to happen due to the incorrect application of procedures (Reason, 1990; Stanton & Salmon, 2009).

Reason draws lines between his work and Rasmussen's by noting that mistakes can be divided into two further categories. The first are mistakes due to failures of expertise (Rasmussen's rule-based domain) where a pre-established plan is applied to an inappropriate task or context. The second are mistakes due to lack of expertise (Rasmussen's knowledge-based domain) when an individual does not have an appropriate pre-formed (mental) routine and so is forced to work out a plan of action (Rasmussen, 1982; Rasmussen & Vicente, 1989; Reason, 1990).

In his taxonomy Reason (1990) also includes a further type of error termed violations. Violations are important as they relate to departures from rules, processes and procedures which are put in place by organisations or other

supervisory bodies, in order that a system can function safely. Violations are interesting as they identify the impact that the social context can have on decision making and the execution of actions (Reason, 1990).

Violations can either be intentional or unintentional. An example of an intentional violation in a pharmacy setting would be when a community pharmacist may not carry out the recommended mental break between carrying out a final accuracy check on an item they have dispensed themselves (General Pharmaceutical Council, 2010) because of time constraints (e.g. the patient is waiting in the pharmacy for their medicine).

Table 2.7: Reason's human error taxonomy (Reason, 1990; Stanton & Salmon, 2009)

Error Category	Errors	Cognitive stage
Slip (*attentional failure*)	Misperception Action intrusion Misordering of action Mistiming of action Omission of action Reversal of action Repetitions of action	**Action Execution**
Lapse (*memory failure*)	Omitting of planned actions Losing place in action sequence Forgetting intended actions	**Storage of subroutines**
Mistake (*intention failure*)	Misapplication of good procedure Application of a bad procedure Poor decision making Failure to consider alternatives Overconfidence	**Planning of the subroutines needed**
Violations	Intentional violation Unintentional violation	**Planning of the subroutines needed**

2.6.2. The field of human factors

Human factors and ergonomics is an interdisciplinary field which uses knowledge on the physical and mental limitations of humans to design systems, tasks and products that can be safely and effectively used by humans (Proctor & Vu, 2010). The development of this field began just after World War II when experimental psychologists were invited to investigate why pilots were crashing aeroplanes which were not faulty, and other similarly perplexing human errors like those discussed in section 2.6.5 above (Fitts & Jones, 1947; Wickens, et al., 2013). Alphonse

Chapanis (often referred to as one of the founding fathers of human factors) believed that pilot error was in fact designer error and that it was possible to design error tolerant systems. Since the Second World War huge advances in aircraft technology and safety have been made (Dekker, 2011).

Research into the human factors of healthcare safety incidents began as early as the 1960s. For example, Safren and Chapanis (1959) conducted a critical incident study into hospital medication errors shortly after the human factors approach was adopted by the armed forces and aviation industries. The human factors approach has become a key part of improving and maintaining safe systems for industries like aviation and nuclear power. However, the same successes in safety improvement have not been seen in healthcare despite successful research and interventions carried out from the 1960s onwards. A renewed interest in the safety of healthcare within developed countries has occurred since the end of the 20th Century following the publication of the Institute of Medicine report 'to err is human: building a safer healthcare system.' This report revealed that between 44000 and 98000 patients in US hospitals die each year as a result of human error occurring during their care (Kohn, Corrigan, & Donaldson, 1999). Despite this renewed interest, it was recently noted that the National Health Service in the UK remains one of the few safety critical industries which does not have a specialist human factors team, inspectors, or courses for its staff in order to promote best practices for safety (Rhona Flin, Bromiley, Buckle, & Reid, 2013). Reason (1995) suggests that the imperative to take a human factors approach to safety incidents in healthcare has not been as strong as in other industries because medical mishaps mostly affect individuals and are rarely discussed openly. Whereas aeroplane crashes, or nuclear power station incidents generate public and political concern, due to their widespread impact on many individuals and the environment (Reason, 1995).

Initially human factors research focussed on the dials and visual displays which provided operators (e.g. pilots) with information about the functioning of the machine (the aeroplane), and the primary task (flight).

Through studying the design of these systems as Chapanis had suggested, human factors experts found they were able to identify issues which promoted the likelihood of an accident. Once identified, these issues could then be rectified and this reduced errors and accidents. More recent work in the field of human factors has also focussed on the psychosocial factors (individual differences, organisational culture, cognition and work environment), that can lead to accidents and errors as well as on the design of the technology involved (Chapanis, 2004).

2.7. Task characteristics and demands

The characteristics of a task can contribute to both the occurrence of errors and to the MWL experienced. Sometimes a task can be designed in a way that works against the natural functioning of WM and LTM and cause errors (e.g. too much information presented on a computer screen and cause high perceptual load, leading to information being missed). Tasks will also trigger a subjective response to the task, i.e. how a person feels about the task. If a person finds the task challenging then this may create tension and other stress-responses (e.g. MWL) (Grasha, 2001a; 2001b). The characteristics of the accuracy checking task are outlined below, accompanied by current guidance on how pharmacists can maximise the safety of this process. This is followed by research that has considered how the characteristics of the accuracy checking task can lead to errors, and changes in subjective states.

2.7.1. Accuracy checking in pharmacies

Accuracy checking refers to the process pharmacists or accredited checking technicians (ACTs) undertake to verify that a medicine that has been selected, prepared, labelled and assembled by a pharmacist or pharmacy technician conforms to details specified on the prescription (James, 2011; James, Davies, Kinchin, Patel, & Whittlesea, 2010). It is recommended, but not a legal requirement that a dispensed medicine should undergo an accuracy check before it is given to the patient as the purpose of this process is to overcome any weaknesses in the earlier stages of the dispensing process (RPS Support, 2011).

Anto et al (2013) interviewed pharmacists and ACTs to identify how they carried out these checks. All participants checked the dispensed item against the prescription, and secondly against the label. They would also check the label against the prescription. The order in which this was done varied, but always started with verification of the prescription details before looking at the dispensed item or the label (Anto, et al., 2013). This study also found that pharmacists and ACTs often used specific techniques to aid this process. For example, many reported using a mental checklist as they were running through this process or physically tick on the medicine box and label when they checked each aspect (e.g. drug name, dose, formulation) against the prescription. Some pharmacists and ACTs would read the label directions aloud especially, if they felt they were under pressure, and others would arrange the dispensed medicines in the order that they appeared on the prescription (if the prescription had multiple items) (Anto, et al., 2013).

Some guidance on how to carry out an accuracy check and how to reduce the risk of making a dispensing error at each stage of the dispensing process has been provided by the General Pharmaceutical Council (GPhC: 2010). The GPhC is the independent regulator of pharmacists, pharmacy technicians and pharmacy premises in Great Britain. Their guidance on conducting an accuracy check recommends that a second 'competent' [5] person, not involved in the medicine assembly process should carry out the accuracy check on the dispensed medicine. Self-checking is not advised, but if second person is not available to check the dispensed item then a mental break is recommended. A mental break can be short, for example dispensing another prescription before returning to check the previous prescription. If a DE has been made in the dispensing process, a mental break will help prevent the same mistake being missed. A mental break means the pharmacist isn't checking the prescription in the same mind-set that caused the DE in the first place (General Pharmaceutical Council, 2010). The guidance also suggests that all accuracy checks should

---

[5]   A competent person is classed as a pharmacist or an accredited checking technician

be made against the original prescription, and read from the prescription first, instead of reading the medicine and then checking if that matches the prescription. Table 2.8 below shows the mnemonic 'HELP' that the GPhC recommends that pharmacists or technicians use when checking an item to ensure they don't miss anything (General Pharmaceutical Council, 2010). Interestingly, the study by Anto et al (2013) found that pharmacists and technicians would use mental checklists to ensure they checked everything they needed to, but that the HELP mnemonic was not routinely used by any of the participants.

Table 2.8: The HELP mnemonic recommended by the GPhC for accuracy checking dispensed medicines (General Pharmaceutical Council, 2010)

H	**"How much"** Open all unsealed cartons and sealed cartons and check that the contents are correct and match the quantity requested on the prescription. Check that the correct patient information leaflet has been included.
E	**"Expiry date"** Check the product is still in date and ensure this is sufficient to cover the treatment period.
L	**"Label"** Check the patient's name, product name, form, strength and dose are the same as on the prescription. Check that the correct and appropriate warning(s) are included on the label.
P	**"Product"** Check that the correct medication and strength which has been requested on the prescription has been supplied.

2.7.2. Accuracy checking training for pharmacists

The study carried out by Anto et al (2013) also found that many pharmacists working in UK community pharmacies reported that they were not taught how to undertake a final accuracy check. For CPs who said they did receive training, the level of reported training varied. The pharmacists in these studies reported that they devised their own process once they entered practice, and built on this as they gained more error wisdom (Anto, et al., 2013; James, 2011; James, et al., 2010). Interestingly, whilst pharmacists report little to no training in accuracy checking, accuracy checking technicians have reported that they receive standardised training in accuracy checking (Anto, et al., 2013).

As pharmacists are not explicitly trained how to check dispensed medicines, James and colleagues studied the competency of hospital pharmacists and pharmacy students at accuracy checking (James, et al., 2010). They did this by asking pharmacists and pharmacy students to complete concept maps detailing the process they undertook when accuracy checking, including the specific details they would check (James, 2011; James, et al., 2010). The level of detail that was expressed in these concept maps varied between pharmacists not just between pharmacists and pharmacy students (James, 2011; James, et al., 2010). Two example concept maps drawn by pharmacists in this study are reproduced in Figures 2.8 and 2.9 below (James, 2011; James, et al., 2010). The participants in this study were also asked to carry out an accuracy check on a set of dispensed items and it was found that "Harriet", who had the most well developed concept map (shown below in Figure 2.8) in the study, was the only participant who identified all the dispensing errors in this study. On the other hand "Justine", who produced a less developed concept map (also shown below in Figure 2.9), identified 92% of the dispensing errors. On looking at the concept maps, one significant difference between these two examples is that "Harriet" identifies what information she checks against the prescription and "Justine" does not indicate whether she checks the label or product against the prescription. Also, "Harriet" carries out extra checks that "Justine" does not. For example she looks for the ward code and hospital number, which would be an extra confirmation that the medication dispensed is for the right person (James, et al., 2010). This is important for hospital pharmacy where many patients on different wards may be prescribed the same medicines. However, James et al (2010) note that "Harriet" did not include a check for the formulation of the medicine dispensed. James' research shows that the level of detailed knowledge required to successfully accuracy check. It also highlighted that many pharmacists and pharmacy students are not checking all the aspects recommended by the GPhC HELP mnemonic (James, 2011; James, et al., 2010).
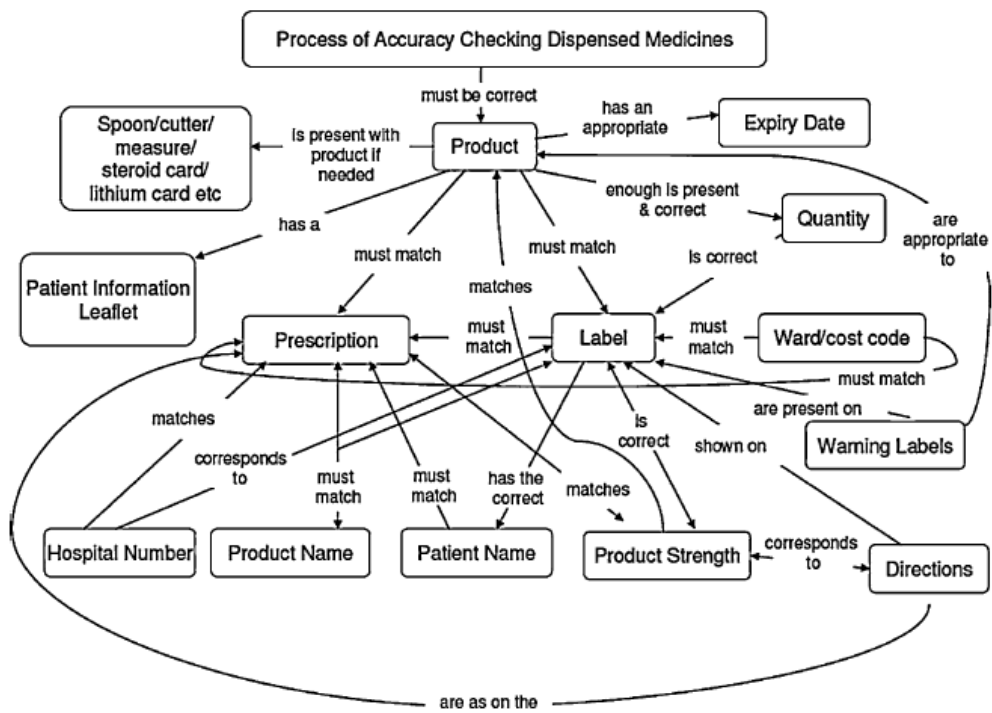
Figure 2.8: *Harriet's (pharmacist) concept map of accuracy checking (From James, et al., 2010, pg 742, with permission)*
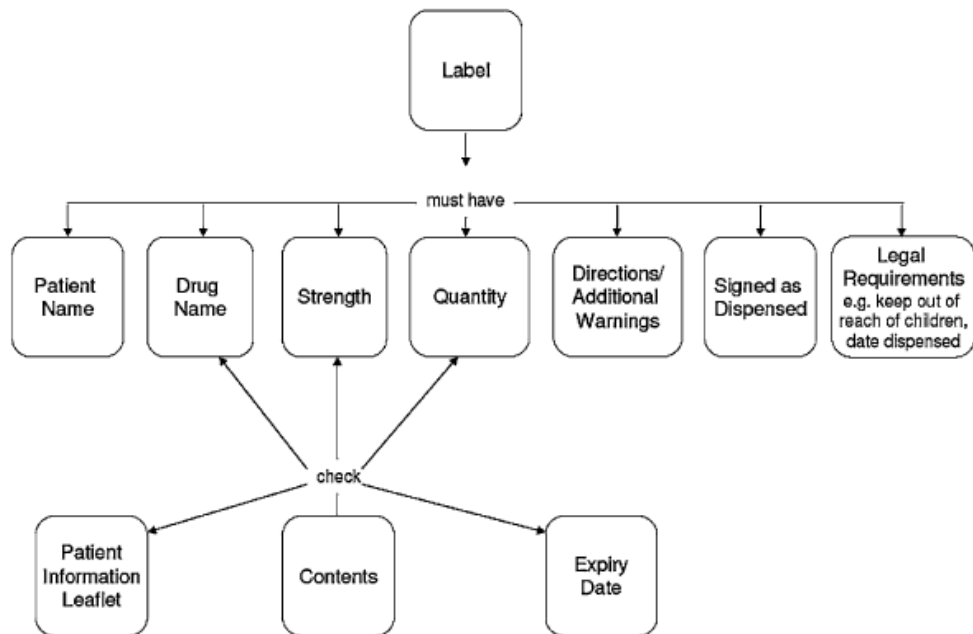
Figure 2.9: *Justine's (pharmacist) concept map of accuracy checking (from James, et al., 2010, pg 743, with permission)*

Some researchers have questioned the utility of the accuracy check (Armitage, 2008; Upton, 2003). One reason for this is because of concerns that it reinforces complacency at earlier stages in the dispensing, preparation or administration process (Armitage, 2008). Also, pharmacists and other healthcare professionals may not place importance on these checks when under time pressure (Armitage, 2008; Upton, 2003). The value of checks may also be limited in some situations where accuracy checks carried out may not be independent. For example talking a colleague through your own checking and dispensing process leads them to make the same mistakes as you because they are following your logic. Checks that are not independent clearly risk undermining the value of accuracy checking (Armitage, 2008). Despite criticisms of this process it is still widely used in community and hospital pharmacies.

2.7.3. Task characteristics and the success of accuracy checking

This section reviews research which has been conducted into the characteristics of the task which can affect the success of an accuracy checking task. One characteristic of the accuracy check task that has been studied are the fonts used on medicines labels. A simulated accuracy checking study which compared 6 point and 12 point labels, found that the smaller font size was linked to reduced detection of dispensing errors (Reilley, et al., 2003). Guidance issued by the former National Patient Safety Agency suggests that the most important information on the label should be printed in a minimum of 12 point font size. So this would usually be the directions on how to use the medicine (Latham, Waller, & Schaitel, 2011; NPSA, 2007a). Although this guidance also advises uses smaller fonts for other information on the label. This guidance was designed with the patient in mind, but smaller fonts advised for the printing of the medicine name and dose on the label may reduce CPs ability to detect DEs. Furthermore a study carried out since this guidance was published found that the font size used on medicine labels obtained from four pharmacy chains did not conform to this guidance with directions on how to use the medicine being printed in 8 or 10 point font size (Latham, et al., 2011). This research suggests that not only are current

labelling formats difficult for some patients to read, the font sizes used may also be undermining the safety checks being carried out by pharmacists.

Another more unusual characteristic of accuracy checking tasks is that DEs do not occur that often. This means that the signal probability (the probability that an error is present in the dispensed item being checked) is low in accuracy checking tasks as many items a pharmacist checks will be error free. Low signal probability has been found to reduce task success in other complex visual search tasks, for example hand luggage checks at airport security (Van Wert, Horowitz, & Wolfe, 2009; Wolfe, Horowitz, & Kenner, 2005; Wolfe et al., 2007). The simulated airport hand luggage checking studies by Wolfe et al showed that as signal probability decreased the observer's ability to detect the signal was also decreased. If these results were applied to the accuracy checking task situation, it would suggest that when less DEs are made during the earlier stages of the dispensing process the pharmacist or accuracy checking technician would be less likely to detect the DEs that had been made. Bilsing-Palacio and Schell (2003) studied the impact of signal probability on DE detection. They found that lower signal probability favoured performance on the accuracy checking task in their study. This finding is contrary to findings in other settings. One reason why their findings may have differed is because in their low signal probability condition 26-30% of the dispensed items contained an error and the high probability condition participants saw a task set of which 34-38% of the items contained dispensing errors. The research carried out by Wolfe et al (2005; 2007) compared signal probabilities of 1%, 10% and 50%, so the signal probabilities used by Bilsing-Palacio and Schell (2003) are not directly comparable. This effect may also be due to the difference between novice and expert participants as the participants in Wolfe et al's research were all trained airport baggage security staff and completed many more visual searches in their task. Biling-Palacio and Schell (2003) recruited undergraduate psychology students to take part in their study who had not carried out a simulated pharmacy accuracy checking task before. Wolfe et al suggest that the

signal probability is likely to reduce detection of targets because the lower frequency of targets leads to an expectation that few targets will be found, and this in turn can lead to an earlier termination of the visual search (Chun & Wolfe, 1996).

The amount of work and the time available to carry out the work is also defined as a task characteristic by Grasha (2001b). The volume of work (or objective WL) was found to reduce performance at accuracy checking (Reilley, et al., 2002). In this study participants (who were undergraduate psychologists) were either given 120 or 72 mock dispensed items (quantities of nuts and bolts in medicine bottles) to check against mock prescriptions, in 120 minutes. Participants who had 120 items to check missed significantly more dispensing errors compared to participants who had fewer items to check. Interestingly most of the errors missed were labelling errors not product or quantity errors (Reilley, et al., 2002) suggesting that participants in each group may have undertaken a different checking procedure. Participants in the high WL group may also have been intentionally sacrificing checking the label in order to complete the task on time. This strategy is called "task shedding" (Wickens, et al., 2013). Another strategy that pharmacists may use when under high WL is, performance reduction where they stop aiming for perfect performance (Wickens, et al., 2013). An example of this strategy may be not taking the time to stick the label on the medicine so that the label edges are straight, or not signing the checked box on the medicine label after carrying out an accuracy check.

Chui et al (2011) also looked at the task characteristics that affected accuracy checking performance. They carried out a postal survey with CPs in the USA to find out whether CPs perceived that different pharmacy tasks (and different stages of the dispensing process) were associated with specific aspects of MWL (e.g. physical, mental, or temporal demand) and what types of workplace pressures reduced their confidence in their ability to complete these tasks safely (e.g. distractions compared to high volumes of work). In agreement with the findings made by Reilley et al (2002) they

found that checking accuracy was perceived by CPs to be reduced by time pressure (an aspect of MWL) and the volume of work.

2.8. Individual difference factors

People vary greatly in the tasks they enjoy doing, the topics they are interested in and the tasks they excel at compared to others. People also vary in their response to stressors in the workplace. Many researchers have argued that models of information processing must be able to account for individual task preferences and differences in performance on tasks (Revelle, 1993). In the CSM individual difference factors, termed 'personal factors' are highlighted to affect performance. These factors include age, sex, personality and expertise for the task (Grasha, 2001b). The characteristics of the individual are also included in many of the definitions of MWL outlined in section 2.5.1 above. Individuals can vary across all aspects of cognition and behaviour, however two key factors are reviewed due to their relevance to MWL and human performance, these are WM capacity, and personality traits. A third important individual difference factor, task expertise, is also highlighted throughout this literature review. This section ends with research that has been carried out to date exploring the impact of individual differences on accuracy checking performance.

2.8.1. Individual differences in WM capacity

A large body of evidence now exists on the differences between individuals in WM capacity (Ilkowska & Engle, 2010, provide a good review). Individuals with greater WM capacity show greater flexibility in allocating attentional resources to meet the demands of a task. This effect is seen in visual search tasks (Bleckley, Durso, Crutchfield, Engle, & Khanna, 2003) and dichotic listening tasks (Colflesh & Conway, 2007; Conway, Cowan, & Bunting, 2001). In all three of these studies, participants higher in WM capacity performed better. However, the strategies they used to allocate attentional resources during the task varied according to the demands of the task. Participants with lower WM span did not vary as much in their allocation of attention (Bleckley, et al., 2003; Colflesh & Conway, 2007; Conway, et al., 2001). Differences in WM

capacity will not only lead to different strategies for the allocation of attention during tasks, it will also likely effect reports of MWL. This is because MWL reports vary according to the amount of WM and attentional processes are involved in a task (Wickens, et al., 2013)

2.8.2. Personality

Current theory suggests that there are five dimensions (or traits) of personality (John, Donahue, & Kentle, 1991; John, Naumann, & Soto, 2008). A large body of evidence exists on the relationship between personality traits and work performance. However, most of the research in human performance and cognition has focussed on the personality traits of extroversion and neuroticism (Revelle, 1993). For example, extroverts tend to perform better in dual-task settings, STM tasks and memory retrieval tasks (Matthews, Davies, Westerman, & Stammers, 2000). However, Koelega (1992) reviewed 56 studies of extroversion and vigilance performance, and found that introverts show a superior detection rate and perceptual sensitivity. This finding is of particular relevance to accuracy checking studies, which are visual search tasks which require quite a high level of vigilance due to the low signal probability (see discussion on signal probability in section 2.7.3 above). Extroverts perform better under conditions which require high levels of arousal compared to introverts (Matthews, et al., 2000). This has been explained using the Yerkes-Dodson law (1908) (described above in section 2.5.2) where extroverts are normally assumed to be under aroused whereas introvert's level of arousal is closer to the optimal level for performance (Matthews, et al., 2000). Introverts performance is worse because their arousal levels rise to a sub-optimal level quicker than the extroverts (Matthews, et al., 2000).

Trait neuroticism (emotional instability) has also been studied in relation to work performance. For example, individuals who score highly on trait neuroticism scales show greater performance decrements compared to individuals low in neuroticism when WL shifts from low to high (Schell & Cox-Fuenzalida, 2005). This finding is of particular relevance to community pharmacy practice as WL patterns can vary greatly throughout the day. Whilst some of these WL shifts can be predicted, for example, WL

increases when patients repeat prescriptions are collected from local general practitioners each morning or afternoon to be dispensed. Other aspects of the WL, for example patients who bring their prescriptions in, cannot be predicted.

2.8.3. Individual difference factors and accuracy checking performance

This section reviews the evidence to date on the individual difference factors that affect accuracy checking performance. Reilley et al (2002) compared the performance of men and women on the accuracy checking task but found no difference. Personality traits and accuracy checking performance has been studied. Higher levels of three personality traits, neuroticism (Schell, et al., 2005), extroversion and conscientiousness (Schell & Reilley, 2004) have been linked to superior performance at accuracy checking. The fact that several traits were linked to superior performance is probably because the two studies were testing accuracy checking performance under different conditions. However, this research was carried out with undergraduate psychologists doing a simulated accuracy checking task, and it could be suggested that underlying personality traits may relate to a person's chosen area of study or work. Therefore, when measuring personality and performance for this task, undergraduate psychology students may not be the most representative sample.

Schell et al (2005) also found that high levels of social anxiety predicted superior performance. This was interesting as participants were not provided feedback on their performance on the task, but may have felt that they were being evaluated, leading to reports of social anxiety. Although there may have been other unknown factors which caused the reports of social anxiety. This may be of relevance to community pharmacy practice as many aspects of this role require interaction with other people, including other healthcare professionals (e.g. general practitioners), members of the public, and pharmacy colleagues (Schell, et al., 2005). However, as this study only examined these effects in the short-term it is unclear whether social anxiety would predict CPs performance over time.

Or whether social anxiety would reduce as CPs or participants became more familiar with the environment and people in the study.

This study by Schell et al (2005) also found that two other personality traits, type A personality trait and an 'internal locus of control' predicted superior performance on their accuracy checking task (however social anxiety was the strongest predictor of performance). Individuals who are identified with the type A personality trait are often considered to be highly strung individuals, who strive for achievement and try to fit as many activities as possible into a period of time (Rose, 1987). Individuals with an internal locus of control are those who believe they are in control of the things that happen to them (e.g. they are in control of their own work performance). On the other hand, individuals said to have an 'external locus of control' predominantly feel that external factors are in control of things that happen to them (e.g. their work performance is a product of the other members of the team they work with or luck) (Ng, Sorensen, & Eby, 2006). Type A personality and internal locus of control traits have also been studied in the job stressor literature where they have been linked to higher reports of job stressors (Spector & O'Connell, 1994). It therefore may be that whilst performance is superior this comes with the cost of mental strain.

A study by Schell and Grasha (2001) which looked at the product preparation stage of dispensing (instead of the checking stage) found that participants who reported greater trait anxiety made more errors when preparing medicines. This result is important when considered in conjunction with the results of the study by Schell et al (2005) as it illustrates the differing effects that individual difference factors can have on each stage of the dispensing process.

Another study by Reilley et al (2003) evaluated the impact of individual differences between participants in controlled and automatic information processing. As individuals gain experience of a task, some aspects of the task can be completed automatically without conscious thought. When this happens tasks may feel less effortful as the process of automaticity frees up conscious mental space to enable the individual to work on other tasks or

think about other things. By contrast controlled information processing occurs with conscious thought and much more effort. These different modes of control relate to Rasmussen's (1982) skill and rule based performance of tasks detailed in section 2.6.5 above. Reilley et al (2003) found that individual differences in controlled but not automatic processing were correlated with performance on the accuracy checking task. Automatic processing has been proposed by other researchers (James, Barlow, Bithell, Hiom, Lord, Pollard, et al., 2013) to underlie medicine errors, yet this is not supported by research by Reilley et al (2003). It could be argued that as participants in this study were undergraduate psychologists, with little experience of the simulated accuracy checking task, the knowledge structures that automatic processes rely on would not have had sufficient time to develop. Therefore, participants were probably still working with a greater level of conscious control than experienced pharmacists would.

2.9. Interpersonal influences

Interpersonal influences are defined in the CSM as relationships experienced in and outside of the pharmacy. CPs are constantly interacting with colleagues in the pharmacy, from other related services (e.g. general practitioners and medicine wholesalers) and patients (or their carers). These interactions on the whole will be routine and positive, but there may also be times when conflict occurs which pharmacists are now trained (through communication skills training) to manage but can become a source of tension for the pharmacist that day. At times a CP may also experience interpersonal issues, both good and bad in their personal lives and this may also become a source of distraction or tension during the working day (Grasha, 2001a; 2001b; Grasha & O'Neill, 1996).

No research to date has looked at interpersonal issues and accuracy checking performance. However, a simulated dispensing study carried out by Grasha & Schell (2001) found that participants who reported significant other relationship stress or higher levels of MWL were more likely to make labelling errors whereas product selection errors were correlated with low social life stress and low MWL. This study did not report whether

significant other relationship stress and MWL levels were correlated. This relationship could hypothetically occur as conscious thoughts about significant other relationship stress would take up some of the limited capacity of the human information processing system.

2.10. Organisational influences

Grasha (2001b) identifies several organisational factors which may affect the performance of the cognitive system. These factors are the formal structure of the organisation, supervisory practices, informal and formal roles of the CP and pharmacy team members. In community pharmacies in GB other organisational influences may also include the type of community pharmacy. At least four types of community pharmacy exist these are the independent, supermarket, small or medium chain and multiple pharmacies. Standard operating procedures (SOPs) for pharmacy tasks will also vary between pharmacies or between pharmacy chains and could have an impact on how tasks are carried out.

James et al (2009) identified several organisational issues in their review of DEs that were reported by hospital and community pharmacists to contribute to DEs. Three papers identified in this review cited lack of procedures and computer software as contributors to DEs, two papers cited lack of training as another contributor.

Grasha (2001a; 2001b) carried out a large-scale study of pharmacists in their place of work, which measured self-reports of prevented DEs (so errors that the pharmacist made but they subsequently detected). Grasha found that more DEs were made by pharmacists who reported that their supervisory support and pharmacy equipment were poor. Pharmacists who felt that they had inadequate breaks also made more DEs (Grasha, 2002b; Grasha, et al., 2001).

2.10.1. Safety culture

The safety culture fostered in community and hospital pharmacies has also been identified as a factor which may be important to the occurrence of DEs. There are many definitions of safety culture and others for safety climate (Flin, Burns, Mearns, Yule, & Robertson, 2006). Generally safety

culture relates to the beliefs, attitudes, work practices and competencies of individuals and groups in an organisation that demonstrate their level of commitment to health and safety management (Ashcroft, Morecroft, Parker, & Noyce, 2005; Cox & Flin, 1998). Ashcroft et al (2005) interviewed CPs and pharmacy support staff to learn about the safety culture that exists in community pharmacies in the UK. This study found that pharmacy staff felt the approach to safety culture in UK community pharmacies was not well developed, citing organisational support as a factor. A more recent study by Phipps and Ashcroft (2011) linked safety climate (which specifically relates to safety attitudes and behaviours) to psychosocial factors. Safety climate, as might be expected, varied by type of pharmacy organisation. However, perceptions of safety climate were also related to perceptions of how much control the pharmacist had over their work, with higher levels of control being associated with more favourable reports of safety climate. Perceptions of high work demand were shown to have a negative effect on perceptions of safety climate (Phipps & Ashcroft, 2011). This indicates the importance of considering psychosocial factors on the safety culture of a pharmacy in general as well as their impact on individual pharmacy team member's cognitive processes.

2.10.2. Sociotechnical Context

In order to fully understand the occurrence of DEs researchers and pharmacists have also recommended a consideration of the socio-technical context of community pharmacy practice. The socio-technical context includes the interactions between people, with technology, equipment, tasks and organisational structures (Phipps, et al., 2009). The socio-technical context is also an important factor which will affect the implementation of new technology and work processes to support community pharmacy work. Harvey et al (2012) identified three different types of socio-technical system which they observed to affect the ways in which early-adopter pharmacies were preparing for implementation of the electronic prescription service (EPS release 2). Some pharmacies were very technical and employed large amounts of technology to support their work. Other pharmacies relied on a strong social network where members

of the pharmacy team would support each other and make allowances for each other in order that all work was carried out efficiently. In pharmacies which had a strong social network, technology was seen as aiding but not central to workflow. Compared to this group the technically focussed pharmacies relied on technology to a greater extent to manage workflow. In the third sociotechnical system identified, pharmacy teams were observed to be working towards unrealistic targets and staff would improvise with any tool available in an attempt to achieve these targets. This final group were called the improvising pharmacies (Harvey, et al., 2012).

The literature presented in this section clearly show how the local pharmacy context can greatly affect the work processes that pharmacists undertake, the systems they work with and how they communicate with colleagues. The next section considers factors external to the organisation which can also influence pharmacy work processes.

2.11. Extra-organisational influences

Grasha (2001b) proposed that extra-organisational factors, including national regulations, policies and procedures that are required to be undertaken by pharmacy staff can also become sources of tension for pharmacists, and potentially affect their cognitive processes. The national pharmacy contractual frameworks were discussed in chapter 1 and this has been shown to have had a significant effect on pharmacy WL, funding and the roles that pharmacists are undertaking (Hassell, et al., 2011). Other extra-organisational issues include the very recent change to the National Health Service (NHS) structure, with the Primary Care Trusts being abolished and replaced with Clinical Commissioning Groups in April 2013. This change affects how local primary care services are commissioned and has led to concerns of pharmacists over the financial security for community pharmacy (News Team, 2013a).

Another pressure CPs have reported is the responsible pharmacist regulations which created a legal responsibility for the pharmacist to ensure the safe and effective running of the pharmacy at all times (TNS UK Ltd, 2011). Where more than one pharmacist is working in a pharmacy on

a shift, one pharmacist will be identified as the responsible pharmacist. In part, the pressure that the responsible pharmacist regulations cause is related to the 1968 Medicines Act (CPS, 2013; HM Government, 1968) under which CPs can be criminally prosecuted for serious DEs (TNS UK Ltd, 2011). The responsible pharmacist legislation also means that when a DE is made by another member of staff the responsible pharmacist during that shift could also be held legally accountable for that DE. The Royal Pharmaceutical Society (RPharmS) is currently working with the UK Government to change the 1968 Medicines Act legislation so that DEs made by a pharmacist or a member of their pharmacy team will no longer be a criminal offence. However, this change to the law has not yet happened so it remains a significant pressure for pharmacy teams (News Team, 2013b).

2.12. The pharmacy environment

Grasha (2001b) identifies several factors in the pharmacy environment which may improve or impair the safety of pharmacy tasks. These factors include levels of illumination, heat and noise. The pharmacy environment as a whole, i.e. the dispensary layout and how work is designed to flow in the environment has also been considered a key factor in safety (NPSA, 2007b). The rest of this section reviews evidence on environmental factors which affect the performance of pharmacy tasks (not limited to accuracy checking).

The study into label font sizes carried out by Reilley et al (2003) reported in section 2.7.3 also looked at whether an illumination and magnification device supported accuracy checking performance. Half the participants were given the illumination device and this aided error detection, but only for participants who were checking dispensed items with 6 point font labels. Interestingly the benefits of this device were only observed for the first part of the study. Reilley et al (2003) suggest that the benefits would be improved if participants were given the freedom to use these devices as and when they felt they were required instead of all the time (as instructed to in this study).

Several self-report studies have found that pharmacists (in all sectors) perceive distractions and interruptions in the pharmacy environment as major contributors to the occurrence of DEs (e.g. (Beso, et al., 2005; Chui, et al., 2011; James, et al., 2009). Interruptions and distractions that occur mid-way through a task that a CP is carrying out will likely cause a prospective memory task. That is the person has to hold (most likely in WM) the intention to go back to the task once the distracting or interrupting signal has been responded to. Therefore frequent interruptions and distractions could place an increased burden on WM processes (Dodhia & Dismukes, 2009).

Two observational studies carried out by Flynn et al (Flynn, et al., 1999; Flynn et al., 1996) have investigated the impact of noise, distractions and interruptions on DEs made in pharmacies. The first study (Flynn, et al., 1996) looked in detail at the impact of ambient sounds (sounds that are happening in the pharmacy environment) on DEs. A pharmacist researcher double checked all medicines dispensed in a retail pharmacy each day (once the pharmacists were happy that they were ready to be given to patients) to identify when DEs were made. Ambient sounds were categorised into two different groups, predictable sounds (sounds that happened regularly in the pharmacy – e.g. label printer) and unpredictable sounds which occurred at unknown times e.g. the first ring of a telephone (further ringing of the telephone becomes a predictable sound). Sounds were also categorised as to whether they were controllable i.e. could the sound be stopped/ changed by the pharmacist (e.g. answering the telephone). The loudness of sounds (in decibels) was also quantified. The results showed that fewer unpredictable sounds were related to higher DE rates, predictable sounds had no effect on DE rates, neither did the controllability of the sound. Noise (which was defined as different to sound as it carried no informational value) was negatively related to DE rates as was the loudness of noise and sound (range 68-82 decibels) (Flynn, et al., 1996). This finding means that as irrelevant background noise increased in frequency and loudness pharmacists made fewer DEs. This effect could be explained in terms of the Yerkes-Dodson law (Yerkes &

Dodson, 1908) with the noise causing an increase in arousal as more effort is mobilised in order to carry out the task under noisier conditions.

The second observational study carried out by Flynn et al (1999) was based in an ambulatory pharmacy and this study looked at interruptions (where work was stopped before completion to respond to the interruption) and distractions (where work was continued, but the pharmacist showed an observable reaction to the distracting stimulus). They found that on average pharmacists were interrupted 3 times per half hour and distracted 4 times per half hour. A study of hospital pharmacy interruptions and distractions found a similar interruption rate (11 per hour). Interestingly sixty-five percent of all the interruptions measured in this study were generated by incoming telephone calls (Burford, Yeck, Tucker, Barker, & Pasupathy, 2011).

In Flynn et al's (1999) study there was a significant increase in error rate during periods when pharmacists were interrupted or distracted. The percentage of dispensed items that contained errors during periods of distraction (6.55%) or interruption (6.65%) was higher than the total error rate found during the study (3.23%). This study also measured the distractibility of pharmacists using the group embedded figures test (which measures cognitive style relating to field independence, poor scores on this test are thought to be related to individuals' level of distractibility). They found that the distractibility of the pharmacist was related to DEs, and when this was controlled for in a regression analysis of dispensing error predictors, interruptions and distractions did not predict errors (Flynn, et al., 1999). This finding highlights the importance of designing work and work environments around individuals and making them safe for people with different types of cognitive styles to work in.

The postal survey carried out by Chui et al (2011) reported above in section 2.7.3 which found that accuracy checking performance was perceived to be impaired under high WL and time pressure, also asked participants about environmental factors which affected their work. The results showed that

patient consultation, clinical and legal checks are perceived by pharmacists to be affected by interruptions and distractions.

2.13. The questions arising from this literature review

The research to date paints a complex picture of the relationship between DEs and MWL. This review has considered MWL and DEs in the context of the CSM (Grasha, 2001b) which highlights how psychosocial factors may lead to reduced efficiency of information processing systems and lead to errors or changes in MWL. There are many as yet unanswered and unexplored issues in relation to DEs and CPs' MWL that have been highlighted in this review. The first question this doctoral research attempts to quantify is how much MWL is involved in a routine accuracy check task? The MWL signatures of each aspect of the dispensing process have not yet been measured. Second, a relationship between DEs and interruptions and distractions has been observed during the dispensing process as a whole (Flynn, et al., 1999). This doctoral research aimed to quantify the impact that interruptions and distractions had on the levels of MWL pharmacists report whilst carrying out an accuracy check task when they are in a distracting and interrupting environment. Chui et al's (2011) postal survey study suggested that interruptions and distractions are perceived by CPs to increase DEs for some but not all aspects of the dispensing process. This doctoral research therefore aims to experimentally measure whether distractions and interruptions reduced accuracy checking performance.

Community pharmacies in the UK may be run each day by a sole pharmacist with the support of a pharmacy team. This means that many recently qualified pharmacists will be taking on the responsible pharmacist roles. James et al (2010) found differences in DE detection between pharmacy student, pre-registration pharmacists and qualified pharmacists. However research to date has not measured the differences in MWL experienced by novice and expert CPs and whether this is linked to reduced detection of DEs.

Research to date also hasn't looked at whether interruptions and distractions affect novice and expert pharmacists in the same way. Theoretically newly qualified pharmacists may be more susceptible to interruptions and distractions. This is because they are likely to be switching between the knowledge and rule-based levels of cognitive control as they experience scenarios not previously encountered (see section 2.6.2) (Rasmussen, 1983). These levels require more mental resources, but also more attention to ensure that the correct implementation of the action. When distractions or interruptions occur divided attention may be more problematic for less experienced pharmacists.

No research to date has measured the levels of MWL UK CPs experience in their day to day work. Survey studies that have been carried out have asked CPs to estimate their MWL in general rather than rating it at certain times during the day or during certain tasks. Research to date has suggested many psychosocial factors which may be related to CPs experiences of MWL. However, the literature on MWL indicates that individuals are motivated to self-regulate their subjective states, including MWL. CPs may therefore be employing coping strategies to manage their MWL. This factor has not yet been explored.

2.14. The aims and objectives of this research

The aims of this study were to:

i. investigate the role of MWL in CPs' and pharmacy students' performance (measured in terms of correctly detected DEs) of a final accuracy check of dispensed medicines, and

ii. investigate community pharmacists' and pharmacy students' MWL during routine pharmacy tasks

iii. study how CPs and pharmacy students manage their work if and when they feel mentally under or overloaded.

iv. Investigate whether expertise in pharmacy tasks impacts on performance on an accuracy checking task and/or the levels of MWL experienced

The objectives of this study were to:

 i.   measure the relationship between perceived MWL and DEs

 ii. measure the differing impact of environment and task characteristics on performance of checking tasks and reported levels of MWL

 iii. evaluate the contribution of individual difference factors (e.g. age, sex, amount of experience, personality traits, mood states) on perceived MWL and performance of a checking task

 iv. explore in depth, CPs' and pharmacy students' individual experiences and perceptions of MWL

 v.   measure the MWL of CPs over a day or a shift in their pharmacy in order to compare MWL levels experienced in the simulated pharmacy setting with those CPs experience in their day to day work.

CHAPTER 3:

METHODOLOGY

"..doing 12 hour days I was finding yeah it was great you know I had 4 days off a week, or 3 days off a week but I couldn't function for the first day I was like a zombie."

Community Pharmacist 3

3.1. Overview of the chapter

This chapter outlines the methodology used in this doctoral research. It begins with an overview of the mixed methods approach and why it has been chosen for this research. Undertaking a mixed methods approach requires careful consideration of the epistemologies that underpin the quantitative and qualitative methodology and how they are managed in a mixed methods study. Some mixed methods researchers have called for this approach to be recognised as the third methodology, this idea is discussed in section 3.4. This chapter continues with a description of how the data and findings from the three studies will be mixed with reference to current theories on the design of mixed methods studies. This chapter ends with a brief outline of the three studies conducted as part of this research.

3.2. Mixed methods research

Using a mixture of research methods in one research project is a relatively new approach having only gained popularity over the last 20-30years (Symonds & Gorard, 2008). Supporters of this approach see it as a way of combining the strengths of the qualitative and quantitative paradigms (Creswell, Fetters, & Ivankova, 2004; Symonds & Gorard, 2008). Johnson, Onwuegbuzie, and Turner (2007) define mixed methods as "…*the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration.*" (p. 123). Researchers may also choose to use mixed methods in order to develop study materials (e.g. conducting a qualitative study to develop a questionnaire for a quantitative study). Alternatively a qualitative study may be combined with a quantitative study in order to explain unexpected or out-lying results obtained in a quantitative study (Creswell, et al., 2004). For these reasons researchers working in applied health research have found a mixed methods approach to be useful (Creswell, et al., 2004).

A mixed methods approach was chosen for this doctoral research for a number of reasons. First, to provide breadth and depth of understanding in relation to the research question as this is a relatively new area of research for pharmacy practice. Second, a quantitative approach is required to objectively measure mental workload (MWL) and its relationship between dispensing errors (DEs). However quantitative methods are not as powerful as qualitative methods for exploring whether sub-optimal MWL is something that CPs experience, what that experience is like or what it means for them in their day to day practice. This aspect of the research is important as a qualitative approach can provide detailed contextual information which can point to ways that suboptimal MWL can be managed within this setting (e.g. through adaptions of standard operating procedures). Although not the primary aim of qualitative research in this setting, it can also enable researchers to gauge whether the issue under study is of relevance to the target population, whether any misconceptions about the issue exist, and whether there may be barriers to change based on the research findings.

3.3. Epistemology

Epistemology is a branch of philosophy concerned with the study of knowledge (Pistrang & Barker, 2012). There are many ways of 'knowing' the world and methods and methodologies can be compared in terms of the types of knowledge they produce. Quantitative and qualitative research methods are often compared based on their epistemological underpinnings, as an understanding of the differences allows inferences to be drawn about what type of knowledge is seen as valid data (J. Green & Thorogood, 2004).

3.3.1. Quantitative epistemology

Quantitative research methods generally assume a positivist approach to knowledge. Positivism was first forwarded by a 19th century French philosopher called Auguste Comte (Pistrang & Barker, 2012). Positivist enquiry is based on the assumption that we exist within a stable reality (realism) and therefore there is a potential right explanation for every

phenomenon that occurs (Breakwell, Hammond, Fife-Schaw, & Smith, 2006; J. Green & Thorogood, 2004). Researchers who subscribe to the positivist point of view also place importance on using research methods and measures that are fully independent (and objective) from the researcher. From this perspective scientific enquiry should also be free from emotional, subjective or political perspectives (J. Green & Thorogood, 2004), i.e. research should be objective and value free (Pistrang & Barker, 2012). Stemming from positivist enquiry is empiricism which focusses on only studying observable phenomena (J. Green & Thorogood, 2004).

3.3.2. Qualitative epistemology

Qualitative researchers in the field of psychology take a range of epistemological standpoints (Willig, 2012), all of which are in near opposition to the positivist tradition (J. Green & Thorogood, 2004; Pistrang & Barker, 2012). The naturalistic enquiry position is often regarded as the core epistemological underpinning for qualitative research. Pistrang and Barker (2012) define this position as aiming to explore and understand the phenomenon in question rather than testing hypotheses. Naturalistic enquiry is concerned more with the inner experience rather than observable behaviour and chooses words rather than numbers to measure this experience (Pistrang & Barker, 2012). Stemming from the broad approach of naturalistic enquiry is the ontological view of social constructivism which sits in direct opposition to realism (described above in section 3.3.1). Social constructivism assumes that reality is socially constructed and therefore there is no objective reality (J. Green & Thorogood, 2004; Pistrang & Barker, 2012). From this perspective research methods cannot be fully independent from the researcher, nor should they be (J. Green & Thorogood, 2004). Qualitative researchers also differ from quantitative researchers in terms of the aspects of the inner experience that they are interested in. For example qualitative researchers who take a phenomenological approach consider people to be sense-makers and so are particularly interested in how people come to understand what their experiences of

the world are like, and why they are like that (Smith, Flowers, & Larkin, 2009).

3.3.3. Mixed methods epistemology

As can be seen from the overview above quantitative and qualitative research methods differ considerably in their underlying epistemology. For this reason individuals taking a mixed methods approach do not align themselves with either of these standpoints. Mixed methods researchers adopt either a pragmatic or transformative paradigm. Pragmatism emphasises the freedom to choose and to find a middle ground between philosophical dogmatisms (Symonds & Gorard, 2008; Teddlie & Tashakkori, 2009). Whereas the transformative paradigm places importance on the lives and experiences of marginalised groups (Teddlie & Tashakkori, 2009). In terms of conducting mixed methods research, there are many similarities between the pragmatic and transformational paradigms. However, researchers taking a transformative approach will specifically emphasise the role of social justice within the collection and analysis of the data. Those taking a transformative approach are also most often researching topics which would seek to minimise a power imbalance between a researcher and participant (e.g. research into minority group issues) (Teddlie & Tashakkori, 2009). The pragmatic and transformative approaches may also vary in terms of the emphasis placed on quantitative and qualitative data in the study (Teddlie & Tashakkori, 2009). With regards to the quantitative and qualitative paradigms, Teddlie and Tashakkori (2009) highlight that mixed methods researchers can choose to be both inductive and deductive in answering their research questions.

3.4. The third research paradigm?

The mixed methods approach is now being so widely utilised that many of its proponents have called for it to be recognised as the third major research paradigm, next to the quantitative and qualitative methodologies (Teddlie & Tashakkori, 2009). However, it has been questioned whether mixed methods truly represents a separate research paradigm (Symonds & Gorard, 2008). This is for many reasons,

but the main criticism is that quantitative and qualitative methodologies are not truly dichotomous. For example, the data collection methods that quantitative and qualitative researchers use are often the same. Also, quantitative research is not always objective, as the choices which inform the research question, through to the choice of data collection tools and analysis of the data can often be subjective. For example, a researcher may choose not to use a data collection technique that they have not used before (Symonds & Gorard, 2008). Another issue is that many studies labelled as mixed methods studies may not be truly mixed methods studies. For example some studies use both quantitative and qualitative methods, but the quantitative and qualitative data are reported separately and the data are not transformed or mixed at any stage of the research. This has led some researchers to question whether such studies represent a mixed methods approach (Creswell, et al., 2004; Symonds & Gorard, 2008). For many researchers, mixed methods may not represent a separate paradigm, for as Gorard, 2007 writes "mixing methods is a bad idea, not because methods should be kept separate but because they should not have been divided at the outset." (p. 1).

3.5. Combining methods in a mixed methods study

Mixed methods studies can differ at several stages of the research process and for this reason Creswell and a task force from the National Institutes of Health (NIH) called for researchers to report specifically how their methods were combined and how the findings were integrated (Creswell, et al., 2004; Office of Behavioural and Social Sciences Research, 2001). First, mixed methods researchers can differ in the priority they give quantitative and qualitative data. For example researchers may use a small qualitative study to design a questionnaire for a larger quantitative study. In this example the priority is given to the findings of the quantitative study (Creswell, et al., 2004). In this doctoral research the quantitative and qualitative research methods are used to answer different research objectives in order to give a more holistic view of the relationship between MWL and DEs. In this

doctoral research the quantitative and qualitative data are given equal priority.

Mixed methods studies also differ in how each method is implemented in the study. Qualitative and quantitative methods may be implemented concurrently or sequentially. With sequential data collection each stage can inform the next, allowing the mixing process to occur throughout the research. This doctoral research took a concurrent approach in order to fit with the times of the year that final year pharmacy students were available to take part in research (due to pharmacy placements and exams) and funding arrangements. The data from this doctoral research is therefore not mixed until they are interpreted together in Chapter 7. This approach to mixed methods research is based on the triangulation design model (Creswell, et al., 2004) which is discussed in the next section.

3.5.1. Triangulating the data

Mixed methods primary care research often takes a triangulation approach (Creswell, et al., 2004). This approach involves the concurrent collection of qualitative and quantitative data (Teddlie & Tashakkori, 2009) and both methods are usually given equal priority (Creswell, et al., 2004). The analysis and results of the quantitative and qualitative research are often reported separately, and then are transformed, or interpreted together in the discussion and conclusions (Creswell, et al., 2004). Data can be transformed into another form to complement the other (e.g. qualitative codes can be counted to provide a quantitative measure (Creswell, et al., 2004; Teddlie & Tashakkori, 2009). However, triangulation often involves discussing the two forms of data as supporting or conflicting evidence, without transforming the data (Creswell, et al., 2004).

In this doctoral research the qualitative and quantitative evidence are triangulated in Chapter 7. Here the evidence is discussed in relation to the extent to which the results of each study supports or conflicts with the findings of the other two studies, or explains unexpected findings. The quantitative MWL diary study (reported in Chapter 5) and the

qualitative interview study (reported in Chapter 6) are used to link the experimental research (reported in Chapter 4) with real-life pharmacy practice. The qualitative data also provide detailed insights into the experiences reported on the questionnaires answered in the experimental and MWL diary studies. In this doctoral research the qualitative data were not transformed because this process would not have aided the triangulation of the data.

3.6. Quantitative Research Methods

Quantitative research aims to measure a phenomenon, behaviour or patterns of behaviour under study rather than just describing it. Quantitative research may involve conducting an experiment on, a questionnaire about, or an observation of human behaviour. Quantitative methods usually produce numerical data which allow groups of participants in a study to be compared, but also across studies (Pistrang & Barker, 2012). Many psychologists and health service researchers favour a quantitative approach as it allows them to explicitly measure the strength of relationships between variables. Some methods, for example, the experimental method can test cause-and-effect relationships (Davis & Bremner, 2006). Within psychology quantitative methods have been favoured because of the importance placed on a scientific approach to the study of human behaviour. These methods have also been favoured in the past in health service research as health care professionals are more familiar with quantitative measures (J. Green & Thorogood, 2004). Quantitative methods allow researchers to test the predictions that models and theories make of human behaviour. This is important as human behaviour is largely driven by unconscious mental processes which the researcher cannot directly observe, and the participant may be unable to report. Approaches that compare behaviour under different conditions (e.g. the experimental method) allow psychologists to draw conclusions about the impact of different conditions on human behaviour (Davis & Bremner, 2006).

3.7. Qualitative research

Qualitative research is concerned with the meaning of people's experiences, how people make sense of these experiences and what is it like to have these experiences. The aim of qualitative research is to attempt to understand the implications and consequences of these experiences for people (Willig, 2012). Qualitative research has been used in other disciplines (e.g. anthropology) since the 19th century. However, the use of qualitative methods in psychology did not occur until the end of the 20th century (Pistrang & Barker, 2012). Qualitative research methods have also been widely used within health service research as it allows researchers to study the ways in which health care services might be improved for the benefit of the patients or healthcare professionals working in them (J. Green & Thorogood, 2004). Qualitative approaches are useful for studying people's experiences of health services because unlike quantitative methodology, qualitative research embraces subjectivity and the experiential aspects of life (Willig, 2012). Qualitative researchers tend to study a relatively small amount of data at a very in-depth level. The data produced by qualitative research methods is often described as textured, and allows researchers to look at contradictions and nuances of human experience (Pistrang & Barker, 2012). Qualitative research is primarily inductive (bottom-up data collection), so it does not set out to test hypotheses derived from existing theories (the hypothetico-deductive or top-down approach) (Willig, 2012). This means that qualitative research is valuable for areas which are under-researched and/or under-theorised (Pistrang & Barker, 2012).

Unlike quantitative research, qualitative research cannot provide evidence on cause-and-effect relationships or the strengths of relationships between variables (Willig, 2012). Qualitative researchers also do not aim to generalise their findings or to develop predictive models of human behaviour (Willig, 2012). For many researchers qualitative research methods are seen as a tool which can be used to reduce the power imbalance between researchers and participants commonly seen in quantitative research. For this reason, qualitative

methods are also used to give a voice for disadvantaged or excluded sub-populations (Pistrang & Barker, 2012).

Qualitative researchers use many different data collection methods including: interviews, focus groups, observations, diary studies, images, videos and questionnaires. It can be seen from this list that many of the methods used by qualitative researchers are also listed above as being used by quantitative researchers. These methods are used in an open ended fashion in order to allow participants the opportunity to describe their own experiences (Pistrang & Barker, 2012). They also need to be participant-led, or bottom-up, in the sense that they allow participant-generated meanings to be heard (Willig, 2001).

3.8. A description of the three studies

In order to fulfil the aims and objectives for this doctoral research outlined at the end of Chapter 2 three studies were conducted using the mixed methods approach described above. A mixed methods approach was chosen because the aims were both to test and explore the relationship between MWL and DEs. Each study is described briefly below with in-depth detail provided in Chapters 4, 5 and 6.

Study 1: testing the relationship between MWL and DEs

Two accuracy checking experiments were carried out for study 1 to measure the relationship between MWL and DEs. Both community pharmacists (CPs) in practice and final year pharmacy students from the University of Bath were recruited to take part in this study. Two experiments were carried out in order to study the impact of MWL on accuracy checking performance in two different ways. In the first experiment half the participants were asked to remember a string of six double digit numbers whilst carrying out the accuracy checking task, whilst the other half of the participants only had one double-digit number to remember whilst accuracy checking. In the second experiment half the participants were interrupted and distracted (and the other half were not) whilst they carried out the accuracy checking task in order to identify whether interruptions and distractions

increased MWL and/or reduced performance on the accuracy checking task. Pharmacy students and CPs were invited to take part in this study in order that their performance on the task could be compared and the impact of expertise on the relationship between MWL and DEs for this task could be studied.

The study was carried out in the pharmacy practice suite at the University of Bath, which is a simulated pharmacy environment. During the study participants took part in the experiments in separate rooms in the pharmacy practice suite so that the environment that each participant took part in could be controlled. It was important to test the relationship between DEs and MWL under controlled conditions as Chapter 2 highlighted the many factors can affect MWL or lead to a DE being made, or missed. Without experimental control it would be impossible to separate out the effects of confounding variables. As this research was carried out under controlled conditions the impact of individual differences between participants on detection of DEs and the amount of MWL experienced could be assessed. This study relates to aims i, ii and iv and objectives i – iii which were outlined in Chapter 2.

Study 2: measuring the levels of MW experienced by community pharmacists in their "real-life" pharmacies

Many of the CPs who took part in the experimental study also agreed to complete a MWL diary. This simply involved rating their MWL at several points during the day. This study was conducted so that the MWL levels reported during the simulated pharmacy tasks could be compared to levels of MWL experienced during real-life practice in order to provide context for the experimental findings. This study relates to aim ii and objective v outlined in Chapter 2.

Study 3: exploring community pharmacists' and pharmacy students' experiences of MW in the dispensary

Several of the pharmacy students and CPs who took part in the experimental study were invited to take part in a qualitative follow-up study. This involved a semi-structured qualitative interview which was designed to explore their experiences of MWL, things in the pharmacy

that caused underload and overload, and whether they had intuitively devised coping strategies for times when their MWL was too high or too low. A study of this nature was important as it provided data on whether suboptimal MWL was something that CPs and pharmacy students regularly experienced when working in the pharmacy. This study relates to aims ii and iii, and objective iv outlined in Chapter 2.

3.9. Summary of the chapter

This chapter has presented the theoretical framework underpinning this research. The types of evidence that each approach provides has been discussed and the assumptions that are made on the part of the researcher are considered. In the following three chapters, studies 1 to 3 are detailed. For each chapter the methods used and results of the study are detailed and discussed in relation to previous research. In Chapter 7 the findings from the 3 studies are triangulated before conclusions are drawn in Chapter 8.

CHAPTER 4: ACCURACY CHECKING EXPERIMENTS

husbands health + job.

childrens exams + everything else to do with children

job security increasing number of pharmacists

DISPENSING ERRORS.

did I book someone to look after dog + will they turn up!

After 25 years in this job my feet really HURT!

TOO TIRED to do anything by the time I FINALLY get home, housework, social life etc

paperwork + computer recording so time consuming

constant interruptions - phone etc increases risk of

ISOLATION - no other pharmacist at work to discuss queries

I chose the wrong career, TOO OLD to retrain

keeping up to date/CPD

lunch time spent doing paperwork AGAIN

MURS area office rings twice a day to check how many we've done + names + shames people who haven't

I can't wait for 5.30pm 6pm 6.30pm - how much longer can they make the working day!

will vital items arrive in the ORDER

patients waiting, complaints

reliable staff.

NO PENSION

parents health

"If it is very, very busy then I can't shut things out I mean there have been times before where I have had to pull the cord out of the phone to stop it just for a few seconds so that I can think about what I am doing, if I am checking a controlled drug and the phone is going and then someone is asking me to do something at the same time, it is just too much and usually at that point I pick the drugs up pull the phone out and sit in the office or something and check it there, because that is the only place I can get piece of mind and actually focus on the task."

Community Pharmacist 60

4.1. Overview of chapter

In this chapter the methods, and results of two simulated accuracy checking experiments, which form study 1 are reported. The chapter begins with the details and findings of the pilot study which informed the design of the two accuracy checking experiments. The results of the accuracy checking experiments are presented and discussed in relation to the literature presented in Chapters 1 and 2 before the next study, the MWL diary study, is detailed in Chapter 5.

4.2. Pilot study

A small pilot study with pharmacy students and community pharmacists (CPs) was conducted at the beginning of 2011. The main aim of the pilot study was to test the design of the simulated accuracy checking exercises and a battery of pre-validated questionnaires for validity and reliability in a UK pharmacy practice setting. A secondary aim for this pilot study was to assess the impact of signal probability on dispensing error (DE) detection and mental workload (MWL). This was assessed by manipulating the number of DEs deliberately included in the accuracy checking task. Previous experimental research into factors that affect the success of a pharmacy accuracy check has set the DE rate at 24% or higher. Evidence on DE rates in the UK (outlined in Chapter 1) suggests that this error rate is greater than that observed in UK community pharmacy practice. As error rates may affect MWL and DE detection in this study half the participants checked a set of items 24% of which contained errors, and the other half checked a set of items 10% of which contained errors (UK rate). The two groups were then compared to identify if checking dispensed items with different DE rates affected their MWL, DE detection, or other subjective states.

4.2.1. Ethics

The pilot study received ethical approval from The University of Bath, Department for Health Research Ethics Approval Committee for Health (REACH) in December 2010.

4.2.2. Methodology

The pilot study used mixed methods to validate the task design and questionnaires for the two full scale experiments (hereafter referred to as experiments 1 and 2). The 'Think Aloud' technique (also known as protocol analysis) which produces qualitative verbal protocols was used to validate questionnaires for use in this setting (with UK pharmacists and pharmacy students). The simulated accuracy checking task was also piloted.

4.2.3. Methods

Questionnaire Method

Questionnaires are the most commonly used method of data collection in the social sciences. Their popularity is attributed to their versatility, ease of use and the low costs associated with gathering questionnaire data (Fife-Schaw, 2006). Questionnaires are versatile because they can be used to collect both quantitative and qualitative data. Quantitative data is usually gathered through closed questions and rating scales, whereas qualitative data can be gathered through open-ended questions (Fife-Schaw, 2006). There are also many modes of questionnaire delivery. Questionnaires can be administered via computers, websites, telephone, paper and pencil, or by a researcher. In this study participants were asked to complete a paper and pencil battery of questionnaires (see section 4.2.6 for details on the questionnaires used).

Although questionnaires are widely used, they are self-report measures and self-report measures suffer from specific types of measurement error. Measurement errors on self-report tools can occur through biases (e.g. giving a socially desirable answer rather than a true answer), question formats, questionnaire mode, or because some aspects of the behaviour under study are unconscious and therefore the participant cannot report these experiences (Fife-Schaw, 2006). All the questions in this battery of questionnaires were closed format, producing only quantitative data, and the majority of the items were Likert scales, asking participants to rate

their responses to the questions on either on a 4, 5, or 11 point scale. The aim of the Think Aloud technique outlined below is to reduce the impact of reporting biases and formatting issues as much as possible. The mode of delivery is particularly important to consider as it can impact on the responses given to the questions. For example Noyes and Bruneau (2007) found that a when participants rated their MWL on a computerised version of the NASA-TLX (the measure of MWL used in this study) they reported higher MWL than they did when completing the same scale in a paper and pencil format.

The Think Aloud technique

The Think Aloud (TA) technique (Ericsson & Simon, 1993; Fonteyn, Kuipers, & Grobe, 1993; Sudman, Bradburn, & Schwarz, 1996) was used to validate the questionnaires in conjunction with the answers participants gave on the questionnaire items. This method was first used by Newell, Simon and Ericsson (Ericsson & Simon, 1993; Newell & Simon, 1972) to study the development of expertise and they called this technique protocol analysis. Through asking participants to say out loud everything that went through their minds as they were solving a problem, Ericsson and Simon were able to identify distinct differences in the thought processes of novices and experts. Some years later, Bolton (1991) recommended the use of this technique for questionnaire validation and design. Since this time verbal protocols have become particularly useful in identifying measurement error that may be caused by the way a question is worded or structured. There are four stages involved in answering a question and these stages relate to a participants' conscious thought processes when answering a question on a questionnaire, or in any other setting. These stages are (1) comprehension (e.g. understanding correctly what the question / researcher is asking), (2) retrieval (e.g. retrieving memories in order to form an answer), (3) judgement (e.g. how do memories fit the response categories of the question, has the right information been retrieved from memory), and (4) response (e.g. editing of response to give a more socially desirable answer) (Collins, 2003; Sudman, et al., 1996). The

way a question is worded will affect the results of each of the four stages of the question-answer process. This is because the stages are interrelated. For example, if the respondent comprehends the question incorrectly this will affect all the other stages because the respondent retrieves the wrong memories. These memories may then be judged to be correct and used to formulate a response. Asking participants to think aloud can therefore provide data on times when the wording or format of the question interferes with one or more of these stages. However, for some questionnaire items it will be easy to identify when participants have encountered a difficulty in answering the question without needing to undertake a TA study. For example examining the responses to open questions would identify whether participants could reliably answer that question and provide the information the researcher requires. The difficulty for many researchers who study human behaviour is that the rating scales commonly used to measure behaviour (e.g. Likert scales) don't allow for a response which indicates whether the participant has been able to answer the question as intended. This is because a participant responds by circling a number, and so no other information is provided in response to the question (Collins, 2003).

It is unusual to conduct a TA study on questionnaires which have been validated extensively. However, on reading the items of the questionnaires chosen for this study it was felt that there may be some items which could be difficult for some pharmacy students and CPs to answer. This is because many of the Master of Pharmacy students at the University of Bath are international students and so English is not their first language.[6] Similarly many pharmacists practising in the UK may also not have English as their first language. As the majority of the items in the

---

[6] Although Master of Pharmacy students at the University of Bath are required to have a minimum International English Language Testing System score of 7.0 meaning that their spoken English is developed to a sufficient extent to be able to study and practice pharmacy.

questionnaires chosen for this study were answered through circling a number on a rating scale it was not possible to identify whether a question had been answered as originally intended and so a TA study was undertaken. The TA study also allowed for validation of the use of the questionnaires chosen in conjunction with each other and to ensure that using them together would not cause any reactivity effects or measurement errors (French & Sutton, 2011).

There are two types of TA study, the concurrent and retrospective methods. The concurrent TA requires participants to think aloud (in the main unprompted) whilst answering questionnaire items, their verbalisations are recorded and analysed. Retrospective methods involve the questionnaire being administered through an interview. After each question the participant is asked by the interviewer what they understood about the question and how they answered it (Sudman, et al., 1996).

The concurrent TA method was used in this pilot study for two reasons. First, the questionnaires under study were all validated for self-administration and so the concurrent method allows participants to complete the questionnaire as they would in experiments 1 and 2. Second, the retrospective method is more time consuming at the data collection stage.

The retrospective and concurrent TA methods have their own strengths and weaknesses in terms of the information they yield about characteristics of questionnaires. The retrospective method allows the researcher to gather data on all four aspects of the cognitive processes that occur when answering a question, using detailed probes (Sudman, et al., 1996). Sudman et al (1996) suggest the concurrent method may not provide information on comprehension and response issues unless the participant is directly prompted. However, the benefit of the concurrent method is that there are few or no probes used by the researcher during the task and therefore the probes cannot bias the TA verbalisations or the way the respondent answers future questions (Ericsson & Simon, 1993). To

encourage participants in this study to report comprehension issues, they were informed at the beginning of the study that the aim of the TA technique was to ensure that the wording and layout of questions was appropriate.

The experimental method

One of the main quantitative approaches in psychology is the experimental method. The experimental method was first used in psychology in the 1860s by Hermann Von Helmholtz, a German scientist interested in psychophysics. The first psychology laboratory was founded a few years later by his colleague Wilhelm Wundt (often referred to as the grandfather of psychology) (Davis & Bremner, 2006; Jarrett, 2011). Since the nineteenth century the experimental approach has been widely adopted by psychologists. The power of the experimental approach is that it allows researchers to address the problem of explanation. Instead of describing a behavioural phenomenon, a well-designed experiment can provide answers to how and why the behaviour occurs (Davis & Bremner, 2006). Experiments also allow for causal links to be tested (Davis & Bremner, 2006). This is particularly important when attempting to measure mental processes that frequently occur without conscious realisation on the part of the participant in the study, and cannot be objectively "seen" by the researcher. Simply measuring relationships could lead to conclusions based on a misinterpreted correlation.

Grasha (2002a) also highlighted the importance of the experimental approach to understanding the relationship between workload (WL) and DEs. He states that in order to produce generalisable evidence on these relationships, researchers have to go beyond personal reflections on DEs in pharmacies and measure what happens for a group of people who encounter the same factor in their workplace (Grasha, 2002a).

An experimental approach was undertaken in the pilot study to identify whether signal probability would have a significant effect on pharmacy students and community pharmacists ability to detect dispensing errors. It

was hypothesized that participants in the lower signal probability condition (10% DE rate) would miss significantly more DEs than participants in the higher signal probability condition (24% DE rate).

4.2.4. Participants

Eighteen students who were enrolled on the University of Bath Master of Pharmacy (MPharm) degree programme took part in the study. Pharmacy student participants were all in their final year, had undertaken at least one placement in a hospital or community pharmacy and passed their dispensing examinations. An opportunity sample of seven CPs who were also working at the University of Bath as a member of staff or a postgraduate student were also recruited to take part in this study. Participants were those who responded to an e-mail invitation to participate in the study. All participants provided written informed consent before participation, but were given the option to participate in the pilot study without thinking aloud. All 25 participants completed the questionnaires and the checking tasks, but two pharmacy students and two CPs opted-out of the TA study for the questionnaire leaving a sample size of 21 participants for this aspect of the study. All participants received £15 for taking part in the pilot study. A further four post-graduate students who were also CPs were recruited as a small sample to run a second TA study following some small changes to the questionnaire items (detailed in the pilot study results, see section 4.2.9).

Five males and 9 females took part in the low signal probability condition and 3 males and 8 females took part in the high signal probability condition. Further demographics for the participants who took part in the accuracy checking task and first TA study (n=25) are presented below in Table 4.1.

Table 4.1: Pilot study participant demographics

Demographic characteristic	Low signal probability (n= 14)		High signal probability (n=11)	
	Mean	**S.D.**	**Mean**	**S.D.**
Age	24.07	5.08	27.18	9.05
Amount of community pharmacy experience (weeks)	117.50	231.70	184.45	377.66
Amount of hospital pharmacy experience (weeks)	12.36	18.09	2.11	4.31

4.2.5. Study Design

The experiment employed a between participants design with two conditions. A between participants design was chosen instead of a repeated measures design because the time required to complete a small accuracy checking task is quite high compared to other visual search studies. The signal probabilities used in this pilot study were also much lower in both conditions (to be realistic to real life) compared to traditional visual search studies where targets are placed on 50% of trials (Wolfe, Horowitz, & Kenner, 2005). In order to collect a sufficient number of responses to targets under one condition it was required that participants check at least 50 items (where a minimum of 5 items were deliberate DEs). The time involved in checking 50 items is lengthy and participant fatigue may have occurred if participants were required to check a second set of 50 items. To avoid task fatigue, participants could have been invited take part in both conditions over two days. This option was considered but it was felt that this would cause different confounding effects (e.g. participants may be in a different mood state on the second day) and so this approach was not chosen. However, choosing a between participants (or independent samples) design meant accepting a lower level of control over individual difference factors. To minimise this bias as much as possible, participants were randomly allocated to a group.

4.2.6. Materials

Questionnaires

In Chapter 2 the impact of task design and environment on employee's subjective states was discussed. This discussion suggested that subjective states (including MWL) may relate to self-regulatory processes that occur in relation to task and environmental demands and that this process was thought to be affected by stable individual difference factors e.g. personality. As MWL is only one subjective state that is affected by work demands, a battery of questionnaires which measured a range of states relevant to work demands and human performance was chosen for this study. The questionnaire battery used was the Dundee stress state questionnaire (DSSQ) (Matthews et al., 2002; Matthews et al., 1999). This was accompanied by a measure of personality, the Big Five personality index (BFI) (John, Donahue, & Kentle, 1991; John, Naumann, & Soto, 2008). This study used the same subjective state questionnaire battery as previous researchers who have studied the factors that affect final accuracy check performance (Grasha, Reilley, Schell, & Tranum, 2001; Reilley, et al., 2003; Reilley, et al., 2002). The same scales were chosen so that the results would be comparable, making it possible to build on previous research.

Both the DSSQ and the BFI were assessed in the TA study to ensure that the wording was easy for participants to comprehend. The DSSQ has been validated for use with UK and USA populations and has not been translated into other languages. By contrast the BFI is available in 10 different languages and has a much larger body of evidence of its validity in different settings and cultures. The TA study was carried out for the BFI as well as the DSSQ, which has less extensive validation data, because it is not known whether the validity of either of these questionnaires remains when they are administered together.

The Dundee stress state questionnaire

The DSSQ [7] (Matthews, et al., 2002; Matthews, et al., 1999) is comprised of 96 items, which split into 5 questionnaires with 13 subscales. The questionnaire assesses 11 primary dimensions of mood, motivation, and cognition in performance settings (Matthews et al., 2006). Table 4.3 below reports the 5 questionnaires and the subscales of the DSSQ and the BFI with definitions of what each subscale measures. Patterns of responses across these 11 dimensions relate to three superordinate domains, task engagement, distress and worry which represent the self-regulatory processes that occur in relation to different types of tasks (Matthews, et al., 2002). The questionnaire items in the DSSQ were developed from a mixture of pre-existing scales and items on stress-related constructs important to task performance. For example, the DSSQ includes the NASA-TLX (Hart & Staveland, 1988) which is a highly regarded and widely used measure of MWL (Nygren, 1991). Items in the DSSQ are measured on 4 point, 5 point and 11 point Likert scales. Previous experimental studies have shown that the DSSQ scales are appropriately sensitive to task and environmental stressors (Matthews, et al., 2002; Shaw et al., 2010). Individual item scores were reversed where required and then subscale scores for each scale were calculated according to the authors guidelines (Matthews, et al., 2002). The DSSQ was administered before the first task in order to collect baseline data. It was then repeated after each task so that changes in subjective states, in response to each task, could be measured. Further details on the scale, and example items can be found in Appendix 3.

Personality traits and demographics

Personality traits were measured using the Big Five Inventory (Benet-Martinez & John, 1998; John, et al., 1991; John, et al., 2008). The scale has 44 items rated on a five point scale where '1' indicates that a participant 'strongly disagrees' with a statement and '5' indicates they 'strongly agree'

---

[7] Version 1.3 of this scale was used in this study

with a statement. Scores were reversed and summarised according to the BFI instructions, this produced five summary scores reflecting the five dimensions of personality (these traits are outlined in Table 4.2 below). Further details on the scale, and example items can be found in Appendix 3.

Participants were also asked to indicate their age and sex and amount of time spent in pharmacy work experience placements. Time spent in pharmacy work experience placements was measured because the students and community pharmacists who took part in the study had varying amounts of experience of performing an accuracy check on dispensed items. A measure of pharmacy experience was important because the mental processes used to carry out the task, MWL and task performance will likely vary with task expertise (Ericsson & Towne, 2010). It should be noted however, that pharmacy experience is not a direct measure of accuracy checking expertise. However it did allow for a robust measure of more general pharmacy expertise, as a question on the amount of experience the participants had in accuracy checking tasks would have been harder to report. Participants were asked to indicate whether English was their first language or not so that this could be taken into account in the analysis. International students represent a large proportion of the student pharmacist population at the University of Bath and there are also many practising community pharmacists in the UK whose first language is not English. This is important as working in a second language may increase the MWL of tasks like accuracy checking.

Table 4.2: The Big Five Personality Traits

Big Five Personality Trait	Trait description
Openness to experience	Assesses proactive seeking and appreciation of experience. An interest in exploration of the unfamiliar. Those who score highly on this trait are curious, creative, imaginative, untraditional and have broad interests. Those who score low on this scale tend to be more conventional, down-to-earth, not artistic or analytical.
Conscientiousness	Assesses the individual's level of organization, persistence and motivation in goal directed behaviour. Highly conscientious people are reliable, hard-working, self-disciplined and punctual. Those who score low on this trait tend to be aimless, unreliable, lazy, weak-willed and hedonistic.
Extraversion	Assesses the quantity and intensity of interpersonal interaction, activity levels, need for stimulation and capacity for joy. A person who scores high on trait extraversion may, for example be a more sociable, active, talkative, person orientated and optimistic compared to someone who scores low on this trait who would be described as more reserved, aloof, un-exuberant, quiet and task oriented.
Agreeableness	Assesses the quality of one's interpersonal interactions. Those who score high on this trait are soft-hearted, good natured, trusting, helpful and those who score low on this trait are cynical, rude and uncooperative.
Neuroticism	Assesses emotional stability. A person who scores highly on trait neuroticism may, for example, tend to worry more, be more nervous and experience more feelings of insecurity compared to most, by comparison those who score low on trait neuroticism tend to be calm, relaxed, less emotional and secure.

Table   adapted   from   Pervin   and   John   (2001,   Table   8.1,   p.25)

Table 4.3: The five DSSQ questionnaires and the 13 subscales with definitions

DSSQ scales and subscales	Subscale description
Mood states	The mood scale used in the DSSQ is the UWIST Mood Adjective Checklist (Matthews, Jones, & Chamberlain, 1990). Each item is scored on a 4-point scale that ranges from 1- "definitely" to 4 – "definitely not."
Energetic Arousal	Measures moods ranging from feeling sleepy to awake. The subscale is scored out of 32 and higher scores equal feeling awake.
Tense Arousal	Measures moods ranging from feeling calm to nervous. This subscale is also scored out of 32 with higher scores representing greater feelings of calm.
Hedonic Tone	Measures mood states ranging from positive to negative, scored out of 32 and higher scores represent a more positive mood.
Anger / Frustration	Measures levels of anger and frustration, this scale is scored out of 20 and high scores equate to higher levels of anger and frustration.
Motivation	The motivation subscale was written specifically for the DSSQ. Each item on the motivation scale is scored on a 4-point scale ranging from 0 - "Not at all" to 4 - "Extremely."
Intrinsic Motivation	Intrinsic motivation refers to interest in the task. This scale is scored out of 28, high scores represent high levels of intrinsic motivation.
Success Motivation	Success motivation refers to the motivation to excel in performance and at the task, this subscale is scored out of 28 and higher scores equal higher levels of success motivation.
Overall Motivation	This is scored out of 4 and a higher score reflects higher levels of overall motivation
NASA-TLX	Measures the MWL experienced by participants during the task on 6 dimensions (each scored on an 11 point scale ranging from 0 to 10). These dimensions are, mental demand, physical demand, effort, (task) frustration, performance concern and temporal demand (time pressure). Each item can be analysed separately and an overall score is produced (from the mean of the six item scores), to give an overall level of MWL (which is scored in the modified DSSQ version between 0-10) (Hart, 2006; Hart & Staveland, 1988).

Table 4.3 (continued): The five DSSQ questionnaires and the 13 subscales with definitions

DSSQ scales and subscales	Subscale description
Thinking Style	This is the third part of the DSSQ and it measures current mental states, this scale includes modified version of a measure of private self-consciousness or self-focus (Fenigstein, Scheier, & Buss, 1975). It also includes items from Heatherton and Polivy's (1991) self-esteem scales. As well as new items on concentration and perceived control. This scale is scored on a scale of 0-"not at all" to 4 – "extremely"
Self-focussed attention	Self-focussed attention is thought to increase when an individual is experiencing states of stress. This subscale is scored out of 32. High scores equal high levels of stress.
Self-esteem	This measures participants' self-esteem (in the moment rather than in general). This scale is scored out of 28 and high scores indicate high self-esteem.
Control and confidence	This subscale also captures some aspects of self-esteem, but also perceived control within the task environment. This scale is scored out of 28 and high scores equal high levels of control and confidence.
Concentration	This subscale measures current levels of perceived concentration or attention, it is scored out of 28 and high scores represent good concentration.
Thinking Content	This subscale measures mental interference, it is comprised of 16 items from the Cognitive Interference Questionnaire (Sarason, Sarason, Keefe, Hayes, & Shearin, 1986). It is scored on a 5-point scale ranging from 1 - "Never" to 5 - "very often."
Task-relevant interference	Measures how much participants are thinking about the task, in particular their performance of the task and why they are being asked to do the task. Scored out of 40, high scores on this scale may reflect a level of fear or worry over their performance on the task.
Task-irrelevant interference	Measures how much participants are thinking about other things, for example what is going on in their lives. Also scored out of 40, high scores indicate a high level of task-irrelevant interference.

Task items

The checking task items were selected and designed in consultation with qualified CPs and a dispensing technician who all work at the University of Bath. Prescriptions were written using a template designed to mimic the layout and information contained on prescriptions written in the UK and labels were generated using the ePMRx computer software (CoAcS) for pharmacy based labelling and medication records which produces labels identical those normally produced by community and hospital pharmacies. Directions and information on the label were printed in font size 8. An example task item can be seen in Figure 4.1 below. Each dispensed item was given an item number in order for the items to be randomised. Items were randomised for each participant. To do this the list of numbers were entered into a random number generator to determine the order in which each participant would be given items.

Some of the items contained deliberate errors. The errors included in the study are reported in the results section for experiments 1 and 2 (see Tables 4.17 and 4.18 page 159). Errors were designed to imitate those most commonly reported in community pharmacies. In addition, published data on dispensing errors in community pharmacy (Ashcroft, et al., 2005; Chua, et al., 2003; Franklin & O'Grady, 2007; James, et al., 2009) regarding the most frequently reported types of dispensing errors were used to decide which types of errors should be used in this study. Pooling the data from these three studies (Ashcroft, et al., 2005; Chua, et al., 2003; Franklin & O'Grady, 2007) the most common (prevented or unprevented) dispensing error was supply of the wrong drug, followed by the wrong drug name on the medication label, and supply of the wrong quantity of medication.
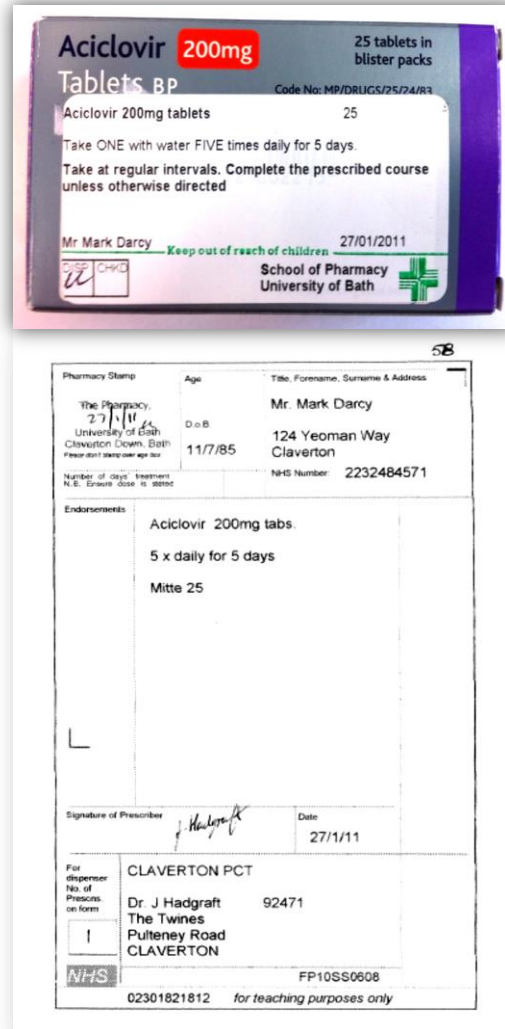
Figure 4.1. Example prescription and dispensed (and labelled) medicine

4.2.7. Procedure

The pilot study was carried out in the student dispensary in the University of Bath Pharmacy Practice Suite. Participants completed the checking tasks in individual consultation rooms which were located off the main dispensary. Participants took part in consultation rooms to isolate them from the researcher and other participants, to control for any environmental factors influencing performance on the checking task (e.g. noise from other participants), and to allow participants to feel comfortable whilst doing the TA task. A baseline questionnaire including the BFI

measure and the DSSQ tool (excluding the NASA-TLX) was completed first. For those participants happy to take part in the TA task, they were instructed to say everything that they thought out loud as they were answering the questionnaire items. They recorded their verbalisations on a digital Dictaphone which the researcher set up before they started the questionnaires. On completion of the first questionnaire the recording was ended.

Next participants were given a box of twenty five dispensed items to check for errors. They were given a set of standardised instructions on how to carry out the task to read before starting the checking task. The two sets of dispensed items were randomised for each participant to prevent any order effects. Participants were instructed to check the dispensed items against a prescription for DEs in the same way they would if working in a community pharmacy. By the side of each participant station there was a second box for participants to place checked items in (so that checked and unchecked items did not get mixed up). When participants identified a DE they were asked to note down on a form, the item number and what they thought the error was before placing the checked item into the spare box.

On completion of the first 25 items, participants were asked to complete the DSSQ measures a second time (this time including the NASA-TLX), participants who were taking part in the TA study, were asked to TA again when they reached the NASA – TLX to provide TA data on all the questionnaires used in this study.

On completion of the second questionnaire participants were given a second box of 25 dispensed items to check and were instructed to follow the same procedure as before. Two hours were allotted for each participant to complete the pilot study. Participants were asked to stop checking after the study had been in progress for 1hour and 45minutes if they had not already completed checking the second set of 25 items they were then asked to complete the DSSQ (including the NASA-TLX) measures one final

time. At the end of the questionnaire participants were thanked and debriefed by the researcher.

4.2.8. Analysis

Think aloud analysis

Following the completion of the questionnaires and the audio recording of the participants' thoughts the recordings are transcribed verbatim and analysed to look for issues that occur during the four stages highlighted in section 4.2.3 above. There are several different coding protocols available for each stage of the question and answer process. On reviewing the literature four coding schemes were chosen, one for each stage of the question and answer process. Comprehension was assessed following Cannell, Foweler & Marquis (1968), and part two and three of Bolton's (1991) coding scheme was used to identify retrieval issues. A simple coding scheme based on Sudman et al (1996) and Collins (2003) was developed to code for judgement and response issues. Full details on each of these coding schemes can be seen in Appendix 1.

This study also followed the criterion recommended by Oskenberg, Cannell and Kalton (1991) to identify questionnaire items which may need amending. This criterion suggests that if 15% or more of the sample experience an issue (even if the problem is coded at different stages of the question and answer process for different participants) then this item needs amending. A second criterion applied in this study was that both pharmacy students and CP participants needed to show evidence of difficulties with an item before it was changed. This second criterion was set so that any changes made were appropriate for both groups of participants. It is standard practice to run a second TA study if changes are made to check that the changes have not caused new response issues.

Checking study analysis

The aim of the simulated final accuracy check task is for participants to detect whether there is an error with a dispensed item. Measurement of

task performance in this study is based on Signal Detection Theory (Green & Swets, 1988). In this study participants must identify DEs (targets) amongst correctly dispensed items (noise). The number of hits (correctly identified DEs), misses (items with DEs which are identified as being error free), false alarms (items which are free of DEs but the participant reports that there is an error present) and correct rejections (items which are DE free and are identified by the participants as DE free) are measured and percentage scores are calculated.

Signal detection theory provides a method for calculating the participants' perceptual sensitivity (how good participants are at identifying what is a dispensing error and what isn't) to DEs and of participants' decision criterion or response bias (the likelihood that they will say yes or no to a DE being present for each item) (Wickens, Hollands, Banbury, & Parasuraman, 2013). As participants made false-alarms it was possible to calculate d-prime (denoted d') scores to index participants' perceptual sensitivity to dispensing errors and the response criterion (denoted by c) was calculated using the method of Macmillan and Creelman (2005). This method can be described by this formula: (norminv (hit) + norminv (false alarm))/−2), which was used to calculate c in Microsoft Excel.

Larger criterion values represent a more conservative response criterion. This means that the observer requires more evidence before they will say 'yes an error (or target) is present' (i.e. they are not strongly biased towards saying yes there is an error (or target) present). Smaller criteria values represent a more liberal criterion, meaning that the observer requires less evidence before they make a decision to say 'yes there is a target present'. More liberal criteria are usually coupled with a higher number of false alarms (saying there is a dispensing error (or target) present when there is not). Higher values of d' (the measure of participants perceptual sensitivity to the targets) indicate an increase in sensitivity to dispensing errors (Wickens, et al., 2004; Wolfe et al., 2007).

4.2.9. Results

The accuracy checking tasks were found to be easy to administer and no changes were made to the delivery of the task.

Time taken to carry out the checking tasks

The amount of time that CPs and pharmacy students took to check each set of 25 items was measured (see Table 4.4 below). The mean time for all participants to check 25 items (averaged across task 1 and task 2) was 30 minutes and 6 seconds and the range was between 19 minutes 30 seconds and 48 minutes.

Table 4.4: Time taken by pharmacy students and CPs to complete the accuracy checking tasks

	Student or Qualified pharmacist	N	Mean (minutes)	Std. Deviation	Std. Error Mean
Time taken to complete first 25 items	Student	18	32.83	7.70	1.81
	Qualified	7	35.57	7.19	2.72
Time taken to complete second 25 items	Student	18	25.65	7.33	1.73
	Qualified	7	29.04	7.2	2.73
Mean time taken to check 25 items	Student	18	29.24	6.74	1.59
	Qualified	7	32.30	4.97	1.88

The impact of signal probability on detection of dispensing errors

Only nine participants managed to detect all the deliberate DEs in the two checking tasks, the remaining participants missed one or more DEs. The checking task data were analysed using non-parametric statistics due to the difference in sample sizes. Two Mann-Whitney U tests were carried out to measure whether the signal probability affected hit rates (correct detection of dispensing errors) or the frequency of false alarms (items incorrectly identified as a dispensing error) across the two checking tasks. No significant difference was found, the signal probability had no effect on DE detection in this study. The mean d' and c values for each group were also compared and no significant differences were found between the groups. Two further Mann-Whitney U tests found no significant

difference in MWL reports after the two checking tasks. Table 4.5 below reports the MWL scores and hit and false alarm rates.

Table 4.5: Hit rates, false alarm rates and MWL scores for the pilot study for the two signal probability conditions and both groups combined

	Error Condition	Mean	Std. Deviation
False alarm rate for both checking tasks	10%	7.10	6.97
	24%	7.91	9.32
Hit rate for both checking tasks	10%	82.86	21.99
	24%	71.82	16.17
Perceptual sensitivity (d′)	10%	2.40	.73
	24%	2.20	.82
Response criterion (C)	10%	.44	.36
	24%	.51	.36
MWL score Task 1	10%	4.51	1.01
	24%	4.39	.99
MWL score Task 2	10%	4.99	.98
	24%	4.35	.98

Findings relating to the questionnaires

The BFI and DSSQ questionnaires were assessed using the TA method (Collins, 2003; Sudman, et al., 1996; van Someren, Barnard, & Sandberg, 1994) to ensure they were appropriate for use in conjunction with each other and in this setting. The TA transcripts revealed that four items on the DSSQ caused comprehension issues for more than 15% of the participants. These four items were found to be problematic by both pharmacy student and CP participants. The issues identified were comprehension difficulties due to the wording of the items. Comprehension issues were also identified for some BFI items, however none of these issues were found for more than 15% of the participants, or for both CPs and pharmacy students.

Two of the items from the DSSQ which the participants had difficulty comprehending were from the UWIST mood state questionnaire (items 7 and 19). One item was from the motivation questionnaire (item 12) and the final item that caused comprehension issues belonged to the thinking style questionnaire (item 17). Some TA quotes from participants who struggled to answer these questions are presented below.

Mood state questionnaire item 7

This item asked participants to rate whether at that moment they felt "passive." Five out of 17 student participants and two of the five CP participants (33% of the participants in total) did not understand the word passive in this item. Below are some example TA quotes for this question.

"Passive don't really know what passive means laid back [pause] mmm passive slightly I'll put a slightly there so in the middle" (Pharmacy Student 5).

"Passive [pause] ummm [pause] passive I dunno how you feel passive [pause] umm I don't really know what that is so no I don't feel passive" (Pharmacy Student 8).

"Err passive mmm a bit more difficult to rate I feel I'm having to think a bit more about it umm probably say slightly not probably feel a bit indifferent about how to answer that one" (Community Pharmacist 19).

Mood State Questionnaire - Item 19

The second mood state item which the TA transcripts highlighted measurement issues that were occurring asked participants to rate how "unenterprising" they felt at the moment.

Seven of the 17 pharmacy student participants and three of the five CP participants did not understand the word unenterprising in this item (48% of the participants in total). Below are some example TA quotes for this question. CP 19 chose to leave this item blank and the other two participants appeared unsure whether their ratings were a true reflection of how they were feeling because they didn't know what unenterprising meant.

"Unenterprising umm [pause] unenterprising. I don't know what to do with that one umm [pause] definitely not - I don't know" (Pharmacy Student 14).

"Unenterprising mm again perhaps slightly more difficult to answer. Umm [long pause] probably leaving this one blank really because I'm perhaps not a hundred

percent sure how to answer it and be sort of truthful really. So I'm going to leave that one blank" (Community Pharmacist Participant 19).

"Unenterprising err not sure hmm unenterprising what does that mean? I'll just say umm slightly" (Community Pharmacist Participant 23).

Motivation questionnaire – item 12

This item asked participants to rate how apathetic they felt about their performance. Four of the 17 pharmacy student participants and one of the five CP participants (24% of the participants overall) did not know what the word apathetic meant in this item. The quotes below indicate that participants were leaving this item unanswered. Unanswered items on this scale would mean that it would not be possible to calculate the success motivation subscale score.

"I feel apathetic about my performance. Right I don't know what that means so [pause] apathetic [pause] right I have to put a question mark next to this because I don't know what apathetic means. [pause] It's probably silly me but [pause]" (Pharmacy Student 11).

"I feel apathetic, apathetic - I'm quite embarrassed now because I don't actually know what that means so I'm going to leave it out" (Community Pharmacist 22)

Thinking style questionnaire – item 17

This item asked participants to rate the extent to which they felt they had less scholastic ability than others. Two of 17 pharmacy student participants and two of the five CP participants did not know what the word scholastic meant in this item (a total of 19% of participants). Again participants chose not to answer this question when they weren't sure what the word scholastic meant.

"I feel that I have less scholastic ability right now than others. [pause] Don't know what that means so I'll put a question mark next to that because I don't know what scholastic ability means" (Pharmacy Student 11).

"Don't know what that means - scholastic" (Community Pharmacist 22).

The TA findings were reported to the author of the DSSQ (Professor Gerald Matthews) who suggested the addition of definitions for the four items which caused issues. These definitions were added as footnotes at the bottom of each scale. The additional definitions for each item were provided by Professor Matthews in order that the originally intended meaning of each item was maintained. These were added to the questionnaires and a second TA study was carried out. Four post-graduate students, who were currently working as CPs part-time, took part in this second TA study.

The addition of footnotes to the four items showed participants used the footnotes, and were then able to answer the questions with ease, for example Community Pharmacist 27 said in response to item 19:

"Unenterprising defined as lacking initiative and drive - no definitely not"

A second participant said in response to this question:

"Unenterprising lacking initiative and drive - no I'm not lacking initiative" (Community Pharmacist 29).

Unexpected scores on the self-focussed attention subscale

On examination of the mean scores on the DSSQ subscales the self-focussed attention subscale showed an unexpected pattern of results. Repeated measures t-tests showed that there was a significant difference between scores at baseline and after task 1 (t(22)=4.16, p<.001, 95% CI[2.53,7.56]) and scores at baseline and after task 2 were also significantly different (t(22)=9.02, p<.001, 95% CI [4.20, 9.02] (see Table 4.6 below for mean scores on this subscale at baseline after task 1, and task 2).

Table 4.6: Self-focussed attention subscale scores for all participants in the pilot study

Self-focussed attention subscale	Mean	Std. Deviation	Std. Error
Baseline score	9.91	6.77	1.41
Score after task 1	4.76	5.39	1.08
Score after task 2	3.40	5.12	1.02

It is not unusual for this subscale to be inflated at the beginning of a study as self-focussed attention usually increases when people are nervous (which would not be an unexpected reaction to taking part in research) (Matthews, et al., 2002). However, as the BFI was combined with the DSSQ there were concerns that the BFI personality scale was causing some response contamination. This would also make sense as participants would have to focus attention on themselves in order to answer to the personality trait questions. There was no direct evidence that this had happened, however there were some quotes from the TA data which suggested some contamination between the questionnaires might have occurred. For example, participant 1 said in response to item two of the thinking style questionnaire (which forms the self-focussed attention subscale): *"I am reflecting about myself I suppose I did earlier."* Pharmacy Student 17 said in response to item five on the thinking content scale *"Umm I thought about my level of ability umm only when prompted to by the questionnaire - so a few times."* It was clear that for some participants previous items were causing contamination. On the basis of these results it was decided that in experiments 1 and 2 participants would be asked to complete the BFI personality the day before taking part in the checking study.

4.2.10. Discussion of pilot study results

The results of the pilot study showed that the accuracy checking task was easy to administer in a standardised and reliable way over a series of participants. Nine of the participants managed to detect all the errors

indicating that the task was possible to complete, but not so much so that ceiling effects[8] were observed. However, contrary to the findings by Bilsing-Palacio et al (2003) no difference in DE detection rates was found between the two groups of participants suggesting that signal probability did not have an effect on detection rates in this study. This difference between the findings of this pilot study and those made by Bilsing-Palacio et al (2003) could have occurred for a number of reasons. First, as this was a pilot study the sample size was small and this may have led to insufficient power to detect differences between the two groups. Second, in the study by Bilsing-Palacio et al (2003) the signal probabilities tested were 26-30% and 34-38% which were different to the 10% and 24% DE probabilities used in this pilot study. Different signal probabilities were used in this pilot study because of differences in DE prevalence rates reported in the UK and the studies carried out by Grasha, Reilley and their colleagues (Grasha, et al., 2001; Reilley, et al., 2003; Reilley, et al., 2002b). However, the results obtained in this pilot study could be a valid finding as the study carried out by Bilsing-Palacio et al (2003) used undergraduate psychology students as participants. Psychology students may perform differently on this task compared to pharmacy students and CPs who all had some experience of similar accuracy checking tasks prior to taking part in the experiment. Although no difference was found for DE detection under different signal probabilities, a 10% signal probability was chosen for experiments 1 and 2. The lower rate was chosen because this is a more accurate reflection of the DE rates reported in the UK DE literature than the higher probabilities used in previous research carried out in the USA (Bilsing-Palacio & Schell, 2003; Grasha, et al., 2001; Reilley, et al., 2003; Reilley, et al., 2002).

---

[8] Ceiling effects refer to times when most of all of the participants perform perfectly on a task (i.e. detect 100% of the DEs in the accuracy checking task). This causes difficulty analysing the data as there is not a sufficient range in the scores. Floor effects can also occur when participants all perform poorly on a task.

The pilot study was also carried out to measure how long it would take participants to carry out an accuracy check of 25 dispensed items. The average time taken was 30minutes and 6 seconds to carry out the checking task. Using this result it was decided that for experiments 1 and 2 participants would be given a time limit of 25 minutes. A stricter time limit was set in order to mimic the reported time pressure in community pharmacies. This time limit was also chosen because participants in similar checking studies were given a time limit based on a minute for every item they were required to check (Reilley, et al., 2002). The time limit was found to be realistic to real-life practice based on personal communication with Dr Lynette James (10.6.2013) who recorded the length of time it took hospital pharmacists to complete each stage of the dispensing process (James et al., 2011). James found that it took hospital pharmacists an average of 45 seconds to carry out an accuracy check on a dispensed item. Although participants in James' study were hospital pharmacists the accuracy check procedure used in hospitals is the same as the procedure used in community pharmacies, therefore this finding can be generalised.

As stated earlier, it is unusual to use the TA technique to evaluate pre-validated questionnaires. However, the verbal protocols provided useful data on the validity of the DSSQ and BFI scales for use with pharmacy students and CPs in this setting. Definitions were added for the four items on the DSSQ which presented difficulty for more than 15% of the participants. This change allowed participants in a follow-up study to be able to answer these questions reliably. The findings of this study also led to the decision to administer the BFI and DSSQ on separate days in experiments 1 and 2, due to concerns that the BFI may be contaminating responses to the DSSQ items that followed. Personality traits measured by the BFI have been found to be stable over time, so the administration of this measure on a different day to the DSSQ and accuracy checking tasks was unlikely to affect participants' responses to these questions.

4.3. Main Study: Experiments 1 and 2

Two simulated pharmacy experiments were carried out. Both experiments required participants to carry out a final accuracy check of a set of 50 pre-dispensed items, some of which contained deliberate DEs.

Experiment 1 sought to understand the relationship between performance on a checking task and MWL. In this experiment half the participants were asked to carry out a secondary number memory task designed to add load to their working memory (WM) processes (high WM load condition), to identify whether this would increase MWL and if additional WM load would affect DE detection.

Experiment 2 sought to measure the impact that interruptions and distractions had on the performance of an accuracy checking task. This experiment also measured the impact that distractions and interruptions had on MWL levels. Half the participants in this experiment were distracted and interrupted. The other half of the participants undertook the accuracy checking task with no distractions or interruptions.

4.3.1. Hypotheses

The following experimental and null hypotheses were tested in experiment one.

H1 Participants in the high WM load condition will have a lower hit rate (correctly identified dispensing errors) compared to participants in the low WM load condition. (see results section 4.3.4)

> H_0: No difference will be found in the hit rates obtained by the participants in the high WM load group compared to the low WM load group.

H2 Pharmacy student participants (in both the high and low WM groups) will achieve a lower hit rate compared to both groups of community pharmacist participants. (see results section 4.3.4)

H0: No difference will be found in the hit rates obtained by the pharmacy student participants compared to the community pharmacist participants.

H3 Participants in the high WM load condition will report higher levels of MWL compared to participants in the low WM load condition. (See results section 4.3.4)

> *H0: No difference will be found in the MWL reports made by the participants in the high WM load group compared to the low WM load group.*

H4 Pharmacy student participants (in both the high and low WM groups) will report higher levels of MWL compared to both groups of community pharmacist participants. (See results section 4.3.4)

> *H0: No difference will be found in the MWL reports made by the pharmacy student participants compared to the community pharmacist participants.*

The following experimental and null hypotheses were tested in experiment two.

H5 Participants in the distraction condition will have a lower hit rate compared to participants in the no-distraction condition. (See results section 4.3.5)

> *H0: No difference will be found in the hit rates obtained by the participants in the distraction condition compared to the no-distraction condition.*

H6 Pharmacy student participants (in both the distraction and no distraction groups) will achieve a lower hit rate compared to both groups of community pharmacist participants. (See results section 4.3.5)

H_0: No difference will be found in the hit rates obtained by the pharmacy student participants compared to the community pharmacist participants.

H7   Participants in the distraction condition will report higher levels of MWL compared to participants in the no-distraction condition. (See results section 4.3.5)

H_0: No difference will be found in the MWL reports made by the participants in the distraction condition compared to the no-distraction condition.

H8   Pharmacy students (in both the distraction and no distraction condition) will report high levels of MWL compared to community pharmacist participants (in both conditions). (See results section 4.3.5)

H_0: No difference will be found in the MWL reports made by the pharmacy student participants compared to the community pharmacist participants.

4.3.2. Ethics

Research ethics approval was granted by the Research Ethics Approval Committee for Health (REACH) at the University of Bath for the pharmacy to carry out experiments 1 and 2 with pharmacy student participants on 16th September 2011 and with the community pharmacist participants on 24th February 2012.

4.3.3. Methods

On receiving ethical approval to carry out experiments 1 and 2 with pharmacy student participants this research commenced in September 2011. The research with the CP participants began in April 2012.

4.3.3.1. Participants

Both pharmacy students and community pharmacists were invited to take part in these experiments. One hundred and four community pharmacists

took part in this study and 93 pharmacy students. Power calculations were carried out to identify how many community pharmacists and pharmacy students would be required to participate in each study. These calculations were based on analyses only comparing two groups of participants (e.g. the two groups of community pharmacists in the two conditions in experiment 1) as the pharmacy student research and CP research were designed as two independent (but complementary) studies. The pharmacy student and CP data have been analysed and reported jointly for the purposes of this thesis. Previous research suggests that a large effect is likely to be observed in both experiments. For example, Recarte and Nunes (2003) found that concurrent mental tasks designed to load cognitive processes reduced detections of targets in visual search by up to 30% compared to the control condition (no extra cognitive loading). Also, the observational study conducted by Flynn et al (1999) found that distractions and interruptions doubled the incidence of DEs. Based on J. Cohen's (1992) widely cited paper on powering research studies adequately, the sample size required to detect a large difference between two independent sample means with power of .80 at α=0.05 is N=52 (26 per condition).

4.3.3.2. Recruitment

Community pharmacists

Recruitment of CPs was carried out on a 'top down' basis. Chief Executives and Superintendent Pharmacists of independent, supermarket, small, medium and large chain pharmacies were contacted directly with information about the study and a request to invite pharmacists employed by their organisation to participate in the study. Agreement was received from eight of the nine largest[9] pharmacy organisations to allow their staff to be recruited to the study, two local medium pharmacy chains and one small pharmacy chain. CPs working in the participating organisations

---

[9] The nine largest pharmacy organisations = Boots, Lloyds, Rowlands, The Co-operative Pharmacy, Superdrug, ASDA, Sainsbury's, Tesco and Morrison's pharmacies.

were contacted by letter inviting them to take part. To comply with the Data Protection Act 1998 this letter was distributed through a gate keeper (e.g. pharmacy manager) except where CPs in each organisation gave their consent for their employers to pass on their contact details to the researcher. The study was also advertised at local pharmacy forum meetings and locum pharmacist agencies, through the study blog and study twitter account. CPs independently expressed an interest in participating in the study when they heard about the research from colleagues, local forms, the research blog or twitter account.

The inclusion criteria for participation were (1) the participants were qualified pharmacists and (2) they were currently working in a UK community pharmacy. Participants were strategically recruited in order to ensure a sample representative of UK CPs was obtained for both experiments 1 and 2. In particular, the researcher endeavoured to recruit CPs from a range of community pharmacy settings as shown below:

- Large chain pharmacies, medium and small chain pharmacies and independent pharmacies
- A range of experience (e.g. CPs who have recently completed their pre-registration training year through to CPs with 20-30 years or more experience working in a community pharmacy).
- Age of CPs
- Full-time and part-time CPs
- Representative proportions of male and female CPs and different ethnicities.

It was made clear to participants that recruitment was a two stage process and that in the case of over subscription of one factor (e.g. a larger number of expressions of interest from CPs who were recently qualified) then they may not be asked to take part.

The workforce census data (Seston & Hassell, 2011) provided the researcher with information on the proportions of pharmacists under each

demographic category (age, sex, ethnicity). This information was used to stratify the recruitment of participants. Years of experience in community pharmacy and working hours were also taken into account, although specific data on these variables were not available. Communication with the Company Chemist's Association (06.04.2012) and the General Pharmaceutical Services report (NHS Information Centre, 2010) provided information relating to the number of independent pharmacies, small and medium pharmacy chains, supermarket pharmacy chains and large pharmacy chains to enable us to recruit a proportionate number of pharmacists from these community pharmacy settings.

As participants were strategically recruited, recruitment for experiments 1 and 2 was concurrent to expedite the process. As access to CPs was reliant on gate-keepers, follow-up of non-response was done through these gate keepers. In the instance of non-response from a pharmacy or chain of pharmacies the researchers contacted the gate-keeper a further two times following initial contact, to ask them to send out a repeat invitation to all the pharmacists they had contacted the first time. This approach meant that some CPs who had already taken part were sent a second unnecessary invitation. However this strategy allowed the researcher to keep the identity of those who had participated in the study confidential. No more than 2 repeat invitations were sent through gate keepers.

Pharmacy student participants

Students enrolled on the University of Bath Masters of Pharmacy course and in their fourth and final year were recruited to take part in experiment 1 and 2. Fourth year students were recruited because they had completed at least one placement in a hospital or community pharmacy prior to taking part and will have completed and passed their final dispensing examinations at the end of the third year. A small number of pharmacy students in their third year were recruited to take part in the study in the summer after they completed their dispensing examinations. Pharmacy students were sent an e-mailed invitation to participate in the study (with

the approval of the Director of Undergraduate Studies). The e-mail included a participant information sheet and details of who to contact for further information and/or to express an interest in participating in the study. To aid recruitment a repeat e-mail was sent on three further occasions. Posters were also displayed around the Pharmacy and Pharmacology department. At the beginning of Semester 1 and Semester 2 the researcher went to the first lecturer which the whole year group attended to introduce themselves and invite students to participate in the study. Unlike the community pharmacist sample, student participants were not strategically recruited due to the limited number of potential participants. Other than the year of study there were no other inclusion criteria. There was only one exclusion criterion and that was if a student had participated in study 1 they could not participate in experiment 2.

4.3.3.3. Participant Payment

Both CP and pharmacy student participants were reimbursed for their participation in the study as follows.

Community pharmacist participant payment

So that CP participants did not have to take time off work to participate in the study, their employers were reimbursed for the time their CPs spent participating in the study or costs for locum cover. However, some participants preferred to take part on a day off and they were therefore reimbursed the equivalent of a locum fee for their participation. This meant that participating CPs received their normal salary or wage for participating in the study. Participants travel expenses to and from the University of Bath were reimbursed.

Pharmacy student participant payment

Pharmacy student participants who took part in experiment 1 were given a £20 shopping voucher as a thank you for taking part in the study.

4.3.3.4. Study environment

Participants took part in the experimental phase of the study in a simulated dispensary (the Pharmacy Practice Suite). Within the dispensary there are three consulting rooms fitted with a telephone point and cordless telephone, a desk and two chairs. The light and room temperature are identical and kept constant (throughout the year) in all three rooms. The consulting rooms provided a controlled environment within which the participants could complete the experiment. Up to two participants took part at a time with one empty consultation room between them (to reduce the travel of noise from the other participant). There were also three further consultation rooms in an adjoining seminar room which were used when one participant was allocated to the distraction condition and another participant to the no distraction condition (so they were not affected by the other participant being distracted and interrupted). These steps were taken to ensure that any differences in performance were due to the experimental manipulations (WM load or distractions and interruptions), and not differences in the lighting, sound levels or temperature of the environment as would have been the case if participants had taken part in the experiment in a real-life community pharmacy.

4.3.3.5. Materials

Questionnaire tools

The questionnaires used in this study are the same as those described in detail above in the pilot study section (see section 4.2.6). A brief outline of each measure is provided below.

Dundee Stress State Questionnaire (DSSQ) (Matthews, et al., 2002; Matthews, et al., 2006) was used to assess transient individual difference factors known to affect performance in the workplace. Specifically the items captured participants' current mood states, motivation and cognitions in relation to themselves and the task.

The NASA-TLX (Hart & Staveland, 1988) is a 6 item questionnaire used to assess the MWL of a task. It is delivered as part of the DSSQ.

The Big Five Inventory (John, et al., 1991; John, et al., 2008) was used to measure participants' personality traits. Personality is a stable individual difference factor which has been linked to performance in other professions and in pharmacy (e.g. Schell & Cox-Fuenzalida, 2005).

To provide demographic data, participants were asked to report their age, sex, amount of community pharmacy and other pharmacy experience, and the last time they worked a shift in a community pharmacy. These items did not come from an existing questionnaire but were validated during the pilot study.

Accuracy checking task items

The aim of the simulated final accuracy checking task was for participants to detect whether a dispensed item contained an error (referred to as task performance). The task items were prepared in the same way as outlined in section 4.2.6 of the pilot study. Five out of the total 50 (10%) dispensed items contained a purposeful DE (this could either be a labelling error or a content error – something that is wrong with the medication, e.g. wrong strength, amount or formulation). In order to keep the study design simple and to be able to measure the effects of the experimental manipulations dispensed items with multiple DEs were not simulated. Although this may happen in real-life. Tables 4.17 and 4.18 on page 159 in the results section reports the different types of errors used in the study.

4.3.3.6. Procedure

Participants who agreed to participate in the study were invited to take part in experiment 1 or 2 at a time convenient to them. Figure 4.2 below shows a flow chart of the procedure for experiment 1 and 2.

Experiment 1: Working Memory

The day before (or earlier) participants were due to take part in experiment 1 they were asked to complete the BFI and the demographic questions.

Participants completed the questionnaire either on a web-based version of the questionnaire or a paper and pencil version (participants were asked to indicate their preference), which was sent to them (by an e-mailed link or posted) on receipt of their expression of interest. Once standard informed consent procedures had been followed participants were seated in one of the consulting rooms and asked to complete the DSSQ. They were then given a set of pre-dispensed items to check and told they had 25 minutes to check the items. Participants were given a timer which counted down how much time was left (as there were no clocks in the study area) to allow them to pace their work in the way they may in practice when working to timed deadlines. All participants in experiment 1 were randomised to either a high or low WM condition.

High WM load condition

Those in the high WM load condition were asked to remember 6 double-figure digits presented to them on a piece of paper for 30 seconds[10] before commencing checking of the dispensed items. They were told that they would be required to recall these numbers to the researcher once they had checked all the items and were not allowed to write these numbers down. Keeping six double digit numbers in mind would add to WM load for the first part of the checking task. In order to maintain memory for the numbers, the participants would have had to rehearse the sequence mentally to stop the memory decaying during the checking task. The addition of this secondary task was to measure whether additional WM load reduced CP and pharmacy student participants' ability to detect DEs due to the availability of fewer cognitive resources.

---

[10] Participants were given 30 seconds to read the list of numbers and rehearse them. This time was chosen as it allowed time to rehearse the sequence at least once so that the memory traces did not decay before the participants started the checking task.

Low WM Condition

Those in the low WM condition were given one double-digit number on a piece of paper for 5 seconds to remember and recall at the end of the checking task. Once the checking task and number recall had been completed participants in both the conditions were given the DSSQ to complete again, this time including the NASA-TLX MWL scale. Once the questionnaires had been completed, an identical checking and number recall task were carried out by participants (they stayed in the same conditions, so those in the high WM load condition received another 6 double digit numbers to remember). On completion of the checking and number recall tasks participants were given the DSSQ and NASA-TLX questionnaires to complete one last time. Participants were then debriefed, thanked and invited to take part in an interview at a later date.

Experiment 2: Distraction

The same procedure used in experiment 1 was followed in experiment 2. However, instead of a high or low WM condition where participants were required to remember numbers whilst carrying out a checking task, in experiment 2 participants were randomly allocated to a distraction or no distraction condition.

No Distraction Condition

In the no distraction condition participants checked 25 items in 25 minutes with no extra tasks and no distractions or interruptions. This group of participants were also the only group not to receive a timer which counted down how much time they had left to complete the task. This was a modification to the original study plan following results from the pharmacy student study, which found that temporal demand (perceived time pressure) was related to hit rates. This was an unexpected result as the time allotted for the task was based on the pilot study findings of how long it would take to check the items at a comfortable pace. The pilot study participants were not given a timer so they were unaware of how much time they had spent completing the checking tasks. Therefore to identify
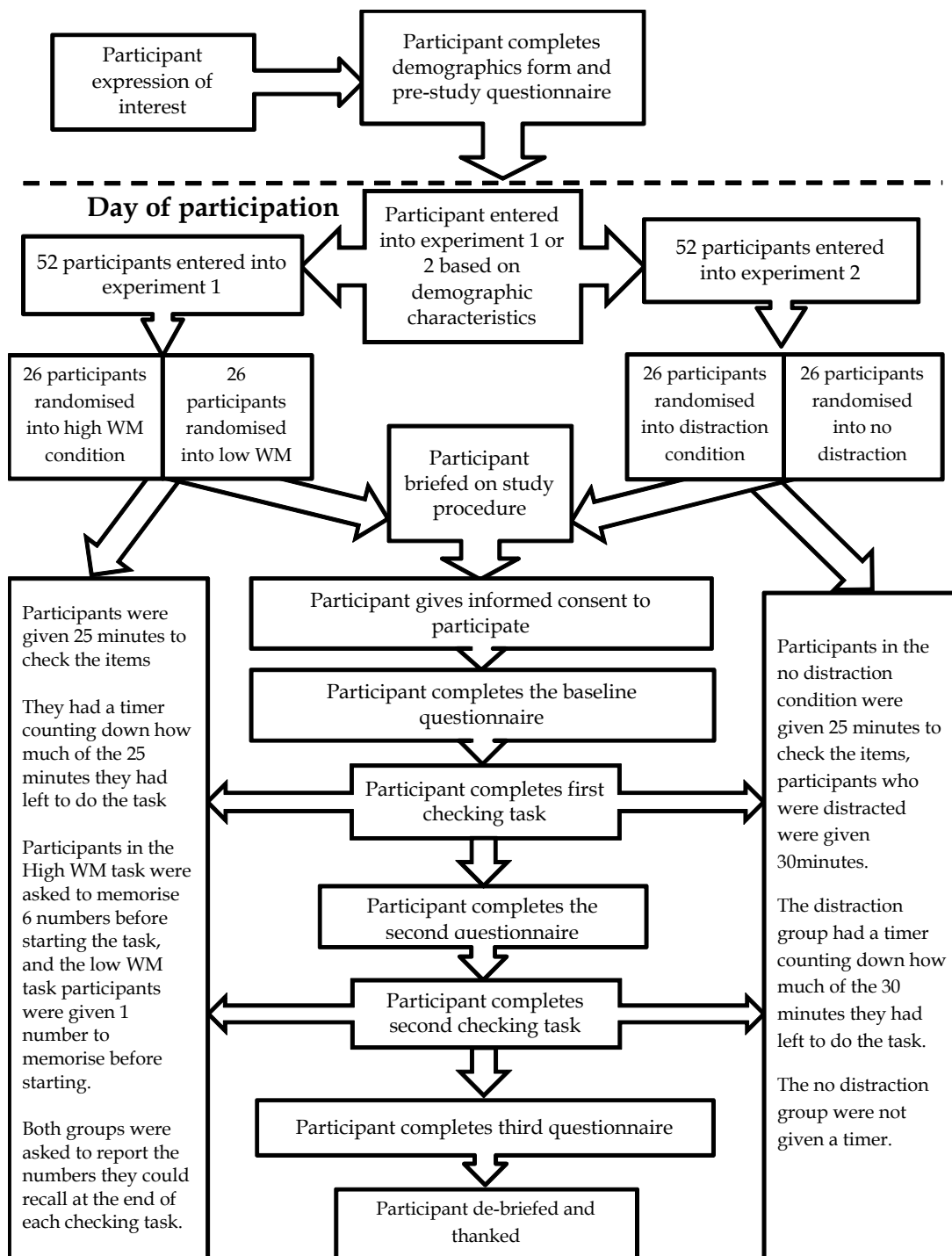
Figure 4.2: Flow chart of the procedure for experiments 1 and 2

whether the presence of a time limit, the time allotted or the timer was related to temporal demand we did not give these 26 participants a timer. As experiments 1 and 2 with the CP sample were running concurrently, it was decided that a no-timer condition would be useful in case similar temporal demand levels were found in experiment 1 with the CPs. The time taken to complete the task was also measured for all participants in experiment 1 and experiment 2. This was done so that the time taken to complete the task could also be correlated with hit rates and temporal demand scores to identify whether these were also related to temporal demand.

Distraction Condition

In the distraction condition participants had 30 minutes to check 25 items. Extra time was allowed for the distraction condition participants. This was required to prevent time pressure becoming a confounding variable that could explain any differences in participants' performance and MWL reports, between the distraction and no distraction conditions. An extra 5 minutes was chosen as the distractions and interruptions (described below) took no more than 5 minutes in total.

As participants only participated in one condition, they did not know that they had received extra or less time compared to the other group. At pre-specified points during the 30 minutes, participants in the distraction condition were deliberately interrupted and attempts were made to distract them from their task as follows:

Task 1

Telephone calls were made to the participant (on the handsets available in the consulting rooms) and they had to answer questions about pharmacy relevant (e.g. have you checked patient XX's medication yet?) and pharmacy irrelevant questions (e.g. what is eight times fourteen?).

- The experimenter opened the door from time to time and put their head into the consultation room (without speaking) where the

participant was checking items, in order to momentarily distract them from what they were doing.

Task 2

- The experimenter entered the consultation room and asked the participant pharmacy relevant or irrelevant questions.

- The telephone was rung once and then stopped ringing before the participant had time to answer it.

- Participants in both the distraction and no distraction condition were informed before-hand to answer the phone if it rang but were not told whether there would be any other interruptions and distractions.

Participants were distracted and interrupted six times during task 1 and a further six times during task 2. This number was based on the findings of previous pharmacy research which suggested that distractions and interruptions each occur 6 times an hour (Flynn, et al., 1999).

4.3.3.7. Statistical Analysis of the data from experiments 1 and 2

All questionnaire and checking task data were entered and analysed using a database created in IBM SPSS Statistics version 20. Before carrying out the analysis the data set was screened for any unexpected or impossible values and for outlying data. Descriptive statistics were produced for participants' characteristics and performance on the tasks. Following the methods outlined in the pilot study, signal detection values d' and c were calculated using the hit rate and false alarm data (see section 4.2.8). Two-way independent ANOVAs were carried out to compare the hit and false alarm rates, perceptual sensitivity (d') and response bias (c) indexes, MWL reports, DSSQ and BFI scores for the four groups of participants in experiment 1. Bivariate correlations were conducted to explore the relationships between the mood state, mental state variables and task performance. Repeated measures t-tests and ANOVAs were carried out to determine how performance, and mood states and mental states changed between task 1 and task 2. The same analyses were carried out for the data collected in experiment 2.

The data from experiments 1 and 2 were pooled and split into two groups based on whether participants had detected all the errors or not. In order to identify whether there were any differences in the characteristics, mood states or mental states of pharmacists who detected all the DEs and those who did not.

4.3.4. Results

4.3.4.1. Experiment 1 results

Participants in experiment 1 were randomly allocated to groups but despite random allocation it can be seen from the participant characteristics in each group (see Table 4.7 below) that the two groups were well matched. There were differences observed in the mean years of experience that participants had in community pharmacy settings, overall pharmacy experience, and the mean number of days since the participants last worked. However two-way independent ANOVAs (for continuous data) and Chi-square analyses (for categorical data) were carried out and showed these differences were not significant for any of the variables listed in Table 4.7 below.

Testing hypotheses H1 and H2

Participants in the high WM load group were asked to remember six, two digit numbers and participants in the low WM load group were asked to remember one two digit number whilst carrying out the accuracy checking task. It was hypothesised (H1) that participants in the high WM load condition would miss more DEs than those in the low WM load condition due to reduced WM capacity.

Table 4.7: Characteristics of participants in experiment 1

Demographics / Characteristics		Low WM load group		High WM load group	
		CP	Student	CP	Student
N		26	26	26	26
Sex	Male (N)	10	2	14	6
	Female (N)	16	24	12	20
Mean Age (years)		41.77	21.73	39.15	22.12
Ethnicity	White (N)	17		17	
	Mixed (N)	1		2	
	Asian (N)	4	Not	7	Not
	Chinese (N)	1	measured	0	measured
	Black (N)	2		0	
Personality Traits (Mean scores)	Openness to Experience	3.33	3.32	3.48	3.36
	Conscientiousness	4.05	3.80	3.88	3.74
	Extraversion	3.33	3.48	3.45	3.46
	Agreeableness	3.93	4.07	3.98	3.96
	Neuroticism	2.56	2.73	2.53	2.87
First Language	English (N)	22	21	20	21
	Other Language (N)	4	5	6	5
Type of Pharmacy the pharmacist participant currently works in	Supermarket (N)	4		2	
	Multiple (N)	9		14	
	Small-Medium Chain (N)	3	Not measured	2	Not measured
	Independent (N)	8		6	
	Locum (N)	2		2	
Pharmacist's working hours	Full-time (N)	18	Not	21	Not
	Part-time (N)	8	measured	5	measured
Mean number of years of community pharmacy experience		16.87	.32	14.20	.71
Mean number of years of pharmacy experience (overall)		18.33	.40	15.30	.77
Mean time since last shift (days)		5.52	228.76	6.87	220.92

Note: Pharmacy students were not asked their ethnicity because this data was only collected for the CP participants to aid the strategic recruitment process. Also because pharmacy students are still at University, many of them do not have a specific pharmacy they work for or set hours so this information was not measured.

A two-way independent ANOVA was carried out with WM load condition and participant group (student or qualified pharmacist for the two independent variables and overall hit rates as the dependent variable). There was no significant effect of WM load condition on DE detection rates

(F(1,100) = .21, p = .65) (see Table 4.8 below). This means that participants in the high WM load condition detected the same proportion of DEs as the participants in the low WM load condition. Therefore the null hypothesis for H1 cannot be rejected.

Table 4.8: Hit rates (percentage of correctly detected DEs) achieved by student and community pharmacists in the high WM and low WM load groups in experiment 1

	WM load condition	Participant group	Mean hit rates (%)	Std. Deviation	Std. Error Mean
Task 1	Low WM	CP	88.46	18.12	3.55
		Student	68.91	29.02	5.69
	High WM	CP	89.74	17.69	3.47
		Student	70.19	24.06	4.72
Task 2	Low WM	CP	76.28	27.15	5.32
		Student	81.41	23.25	4.56
	High WM	CP	75.00	25.50	5.00
		Student	78.85	26.48	5.19
Overall	Low WM	CP	83.08	14.63	2.87
		Student	75.40	18.07	3.54
	High WM	CP	81.92	17.89	3.51
		Student	73.33	20.26	3.97

The second hypothesis (H2) predicted that pharmacy students would achieve lower hit rates when compared to CP participants. As can be seen from Table 4.8 above, the CPs achieved higher hit rates overall, but in the second accuracy checking task pharmacy students' hit rates were higher than the CPs'. The two-way independent samples ANOVA carried out to test hypotheses 1 and 2 showed that there was a significant main effect of pharmacy expertise on overall hit rates (F(1,100)=5.41, p<.05). Hypothesis 2 is accepted. Possible explanations for why the pharmacy students' performance improved between task 1 and task 2 whilst the CPs' performance declined is explored later on in this results section (see section 4.3.4.3).

Differences in perceptual sensitivity and response criteria

Although hit rates did not significantly differ between the two WM load groups, they did between community pharmacist and pharmacy student participants. Response criteria, d′ and false alarm rates were calculated to explore whether the difference in hit rates was due to a difference in perceptual sensitivity (so knowing a dispensing error when they see one) or a difference in their response criterion (how much evidence they require to say that a DE has been made). No specific hypotheses were made for the differences that may occur between participants false alarm rates or the d′ and criterion values, this is therefore an exploratory analysis.

Table 4.9 below shows the mean false alarm rates, d′ and criterion values for the two WM load groups and for pharmacy student and CP participants. Two-way independent ANOVAs were carried out to test for differences in false alarm rates, d′ and criterion values for the two WM groups and between the pharmacy student and CP participants in these groups. No significant differences were found between the participants in the high and low WM load groups for their false alarm rates, d′ or c values. Similarly no difference in these variables was found between the CP and student pharmacist participants in the two WM load groups. There was however a difference found between pharmacy students and CP participants in their d′ (F (1, 100) = 4.23, p<.05) scores but not between participants in the high and low WM condition. Pharmacy student participants had lower d′ values compared to CPs which indicates that their perceptual sensitivity to DEs was lower than community pharmacists. The significance of this finding will be discussed in section 4.3.6.

Table 4.9: False alarm rates, criterion and d' values for pharmacy student and community pharmacist participants in the high and low WM load conditions

	WM load condition	Participant group	Mean value	Std. Deviation
False alarm rates (task 1 and task 2)	Low WM	CP	5.90	7.51
		Student	5.06	7.04
	High WM	CP	3.68	4.40
		Student	6.23	6.49
Criterion value (task 1 and task 2)	Low WM	CP	.43	.30
		Student	.57	.39
	High WM	CP	.53	.34
		Student	.53	.35
d' value (task 1 and task 2)	Low WM	CP	2.62	.66
		Student	2.50	.60
	High WM	CP	2.75	.52
		Student	2.34	.80

Testing hypotheses 3 and 4

It was hypothesised that participants in the high WM load condition would report higher levels of MWL compared to participants in the low WM load condition (H3). A second two-way independent samples ANOVA with WM load condition and pharmacy expertise as the independent variables and overall MWL (mean of scores reported after task 1 and task 2) was carried out. A non-significant effect of WM load on MWL reports was found ($F(1,100) = .004$, p = .952). This means that the participants who had the harder number memory task did not report higher levels of MWL as hypothesised. The null hypothesis therefore cannot be rejected.

It was also predicted that pharmacy student participants (in both the high and low WM groups) would report higher levels of MWL compared to both groups of CP participants (H4). There was a significant main effect of pharmacy expertise on MWL scores ($F(1,100) = 7.61$, p < .01). As can be seen from Table 4.10 below pharmacy students reported significantly higher MWL scores than CPs. Hypothesis 4 is accepted.

Table 4.10: Reported MWL scores for pharmacy student and CP participants in the high and low WM load conditions

	WM load condition	Participant group	Mean MWL score	Std. Deviation	Std. Error Mean
Task 1	Low WM	CP	4.54	1.11	.22
		Student	5.13	1.31	.26
	High WM	CP	4.56	1.24	.24
		Student	5.32	.90	.18
Task 2	Low WM	CP	4.25	1.28	.25
		Student	4.86	1.18	.23
	High WM	CP	4.77	1.24	.24
		Student	5.15	1.00	.20
Overall	Low WM	CP	4.40	1.16	.23
(mean of		Student	5.00	1.19	.23
task 1 and 2	High WM	CP	4.66	1.10	.22
scores)		Student	5.24	.85	.17

4.3.4.2. Experiment 2 Results

Pharmacy student and community pharmacist participants were randomly assigned to conditions. There were some differences observed between participant characteristics (e.g. openness to experience personality trait). A series of two-way ANOVAs (for continuous data) and chi-square analyses (for categorical data) were carried out and showed no significant differences for any of the variables listed in Table 4.11 below.

The impact of distractions and interruptions on dispensing error detection

It was hypothesised that pharmacy student and CP participants who were distracted and interrupted during the accuracy checking tasks would achieve lower hit rates compared to the participants who were not distracted and interrupted (H5). A two-way independent samples ANOVA was carried out to test this hypothesis (and hypothesis 6). In this analysis the distraction condition and pharmacy expertise were independent variables and the dependent variable was DE hit rates (total for both task 1 and 2). No significant effect of distractions and interruptions was found ($F(1, 89) = .014$, p = .906). The null hypothesis for hypothesis 5 cannot be rejected. Distractions did not significantly affect DE detection.

Table 4.11: Characteristics of participants in experiment 2

Demographics / Characteristics		No Distraction group		Distraction group	
		CP	Student	CP	Student
N		26	21	26	20
Sex	Male (N)	14	6	12	5
	Female (N)	12	15	14	15
Mean Age (years)		37.38	22.42	37.27	22.42
Ethnicity	White (N)	17		18	
	Mixed (N)	1		1	
	Asian (N)	5	Not	5	Not
	Chinese (N)	2	measured	1	measured
	Black (N)	1		0	
Personality Traits (Mean scores)	Openness to Experience	3.49	3.09	3.33	3.31
	Conscientiousness	3.77	3.75	4.00	3.70
	Extraversion	3.36	3.28	3.34	3.36
	Agreeableness	3.90	4.08	3.91	4.03
	Neuroticism	2.57	2.73	2.75	2.70
First Language	English (N)	22	15	22	12
	Other Language (N)	4	6	4	8
Type of Pharmacy the pharmacist participant currently works in	Supermarket (N)	4		3	
	Multiple (N)	10		12	
	Small-Medium Chain (N)	2	Not measured	2	Not measured
	Independent (N)	7		7	
	Locum (N)	3		2	
Pharmacist's working hours	Full-time (N)	20	Not measured	20	Not measured
	Part-time (N)	6		6	
Mean number of years of community pharmacy experience		10.65	.52	9.82	.36
Mean number of years of pharmacy experience (overall)		12.97	.86	10.59	.40
Mean time since last shift (days)		1.73	162.12	1.31	86.24

It was also hypothesised that pharmacy student participants (in both the distraction and no distraction groups) would achieve a lower hit rate compared to both groups of CP participants (H6). No main effect for pharmacy experience was found ($F_{(1, 89)}$ = .991, p = .322). The null hypothesis for H6 cannot be rejected. This finding was unexpected as in experiment 1 the pharmacy student and CP participants' overall performance was significantly different and this is not seen in experiment

2. The participants' hit rates can be seen in Table 4.12 below. In task 1 CP participants performed better than the pharmacy student participants. However, in task 2 the pharmacy student participants in the distraction condition out-performed the CP participants. The reasons why CPs' performance declined and pharmacy students' performance improved between the two tasks is explored further in section 4.3.4.3.

Table 4.12: Hit rates (percentage of correctly detected DEs) achieved by student and community pharmacists in the distraction and no distraction groups in experiment 2

	Number memory condition	**Participant group**	**Mean hit rates (%)**	**Std. Deviation**	**Std. Error Mean**
Task 1	No	CP	80.13	21.61	4.24
	Distraction	Student	72.62	26.50	5.78
	Distraction	CP	89.74	17.69	3.47
		Student	78.33	25.99	5.81
Task 2	No	CP	89.74	27.92	5.48
	Distraction	Student	80.16	25.07	5.47
	Distraction	CP	69.87	27.50	5.39
		Student	80.00	26.27	5.87
Overall	No	CP	84.74	15.27	2.99
(mean of	Distraction	Student	75.87	19.17	4.18
task 1 and	Distraction	CP	80.77	15.47	3.03
2 scores)		Student	79.00	18.89	4.22

The impact of distractions and interruptions on mental workload scores

Table 4.13 below reports the MWL scores reported by participants in experiment 2. It was hypothesised that participants in the distraction and interruption group would report higher levels of MWL compared to participants in the no distraction and interruption group (H7). A two-way independent samples ANOVA was carried out to test this hypothesis (and H8). In this analysis the distraction condition and pharmacy expertise were independent variables and the dependent variable was MWL scores (mean of MWL reported after tasks 1 and 2). No significant difference was found in reports of MWL between the two groups of participants ($F(1,89) = 3.76$, $p = .06$). The null hypothesis for H7 cannot be rejected and this means that distractions and interruptions did not significantly affect MWL in this study.

It was also hypothesised that pharmacy student participants (in both the distraction and no distraction group) would report higher levels of MWL compared to community pharmacist participants in both groups (H8). No significant difference was found in MWL reports ($F(1,89) = .26$, p = .11) and therefore the null hypothesis for H8 cannot be rejected either. This finding was unexpected as a significant difference was observed between CP and pharmacy student MWL scores in experiment 1.

Table 4.13: Reported MWL scores for pharmacy student and CP participants in the distraction and no distraction conditions

	Distraction Condition	Participant group	Mean MWL score	Std. Deviation	Std. Error Mean
Task 1	No Distraction	CP	4.81	1.34	.26
	Distraction	Student	5.17	1.30	.28
	Distraction	CP	5.17	1.24	.24
		Student	5.49	.89	.20
Task 2	No Distraction	CP	4.63	1.30	.26
	Distraction	Student	4.80	1.44	.31
	Distraction	CP	4.94	1.24	.24
		Student	5.64	.90	.20
Overall (mean of task 1 and 2 scores)	No Distraction	CP	4.72	1.22	.24
	Distraction	Student	4.98	1.32	.29
	Distraction	CP	5.05	1.09	.21
		Student	5.57	.81	.18

Differences in perceptual sensitivity and response criteria

To identify whether the participants' sensitivity and response criterions were similar to those found in experiment 1 these values were calculated and can be found in Table 4.14 below. These were exploratory analyses and so no hypotheses were tested. Three two-way independent ANOVAs were carried out to identify whether false alarm rates, d' and criterion values differed between participants in the distraction and no distraction condition or between pharmacy student and community pharmacist participants. No significant difference was found between participants in the distraction and no distraction group for their false alarm rates, d' value or criterion value. Also, no significant difference was found between pharmacy student and community pharmacist participants in their

sensitivity to DEs (d′) or false alarm rates. However, a significant difference was found between pharmacy student and CP participants in their criterion values, indicating that the participants in experiment 2 may have been using a different response criterion during the task. Pharmacy students were found to have a more liberal response criterion than the CPs.

Table 4.14: False alarm rates, criteria and d′ values for pharmacy student and CP participants in the distraction and no distraction conditions

	Distraction condition	**Participant group**	**Mean value**	**Std. Deviation**
False alarm rates (task 1 and task 2)	No	CP	6.93	7.55
	Distraction	Student	5.19	6.53
	Distraction	CP	6.33	6.05
		Student	3.56	3.09
Criterion value (task 1 and task 2)	No	CP	.36	.28
	Distraction	Student	.54	.30
	Distraction	CP	.40	.32
		Student	.53	.32
d′ value (task 1 and task 2)	No	CP	2.58	.72
	Distraction	Student	2.45	.68
	Distraction	CP	2.46	.66
		Student	2.67	.55

4.3.4.3. Joint analysis of experiments 1 and 2

Hit rates

A one-way ANOVA was carried out to compare hit rates between the 4 groups of participants (high WM, low WM, distraction, no distraction). No significant difference was found. The mean hit rates for each group can be seen in Tables 4.8 (page 143) and 4.12 (page 148) above.

Mental workload

A series of one-way ANOVAs were carried out to identify whether any differences lay in the overall MWL scores, and scores on individual NASA-TLX items between the four conditions of experiments 1 and 2. A significant difference was found for task frustration scores after task 1 $(F_{(3,193)} = 3.07, p < .05)$ and task 2 $(F_{(3,193)} = 4.06, p < .01)$, and overall

MWL scores for task 2 ($F(3,193)$ = 2.95, p < .05). Gabriel's post-hoc test[11] revealed that task frustration scores after task 1 showed a significant mean difference of 1.50 between the distraction and low WM conditions (p<.05, 95% CI [.16,2.84]) with reports of task frustration being higher for the distraction group. A Games-Howell post hoc procedure[12] revealed that reports of task frustration after task 2 were again significantly different between the distraction and low WM groups (p<.05, 95% CI [.12,2.46]) but also between the high WM group and the low WM group (p<.05, 95% CI [.19,2.47]). A second Gabriel post-hoc test revealed that a significant difference in overall MWL scores occurred between the distraction and low WM groups (p<.05, 95% CI [.05,1.32]). Table 4.15 below reports scores on each of the individual MWL items and overall items for task 1 and task 2. These analyses show that the distraction group experienced significantly more task frustration during both task 1 and task 2 compared to the low WM group. During task 2 the high WM group also reported significantly higher levels of task frustration compared to the low WM group. The distraction group also reported significantly higher MWL after task 2 compared to the low WM group (but not compared to the high WM group or no distraction group).

The mood state of frustration (as opposed to the more specific measure of task frustration) was also measured during this study. Mood states were measured before task 1 (baseline), after task 1, and after the task 2. One-way ANOVAs were carried out to test for differences in the mood state of frustration between the four experimental groups, these revealed that a significant difference in frustration between the groups was reported after

---

[11] Gabriels post-hoc test was chosen as the group sizes were unequal.

[12] Games-Howell post-hoc test was chosen for this analysis as the assumption of homogeneity of variance was not met for this data and which Gabriels test is not appropriate for, but the Games-Howell test is.

Table 4.15: Mean MWL scores (individual NASA-TLX items and overall MWL) reported by the four groups of participants after task 1 and after task 2 (task 2 scores highlighted in grey)

NASA-TLX Item	Experimental condition	Task 1			Task 2		
		Mean	S.D	Std. Error Mean	Mean	S.D.	Std. Error Mean
Mental demand	Low WM	7.42	1.71	.24	7.42	1.75	.24
	High WM	7.56	1.42	.20	7.83	1.53	.21
	No Distraction	7.21	1.67	.24	7.28	1.72	.25
	Distraction	7.74	1.32	.20	8.04	1.15	.17
Physical demand	Low WM	2.31	2.02	.28	2.50	2.13	.30
	High WM	2.67	2.23	.31	2.87	2.37	.33
	No Distraction	2.45	1.98	.29	2.68	2.20	.32
	Distraction	2.52	1.93	.28	3.11	2.33	.34
Temporal demand	Low WM	6.96	2.29	.32	5.88	2.49	.35
	High WM	6.56	2.55	.35	6.10	2.61	.36
	No Distraction	6.68	2.39	.35	6.26	2.59	.38
	Distraction	6.74	2.02	.30	6.43	2.54	.37
Performance concern	Low WM	2.81	1.97	.27	2.42	1.56	.22
	High WM	2.62	1.81	.25	2.33	1.29	.18
	No Distraction	3.13	2.00	.29	2.68	1.55	.23
	Distraction	3.09	1.67	.25	3.02	1.77	.26
Effort	Low WM	6.87	1.73	.24	7.06	1.80	.25
	High WM	7.10	1.43	.20	7.29	1.63	.23
	No Distraction	7.09	1.72	.25	6.79	1.67	.24
	Distraction	7.61	1.36	.20	7.52	1.39	.21
Task frustration	Low WM	2.67	2.23	.31	2.04	1.91	.27
	High WM	3.13	2.59	.36	3.37	2.50	.35
	No Distraction	3.28	2.54	.37	2.55	2.17	.32
	Distraction	4.17	2.59	.38	3.33	2.44	.36
Overall Mental Workload	Low WM	4.84	1.24	.17	4.55	1.26	.17
	High WM	4.94	1.14	.16	4.96	1.13	.16
	No Distraction	4.97	1.32	.19	4.71	1.35	.20
	Distraction	5.31	1.10	.16	5.24	1.15	.17

task 1, but not at baseline or after task 2 ($F(3,193)$ = 3.94, p <.01). A Games-Howell post-hoc analysis revealed that the difference in state frustration scores lay between the low WM group and the distraction group (p<.05, 95% CI [.24, 2.55]). A significant difference was also found between the low WM group frustration scores and the no distraction group (p<.05, 95% CI [.14, 2.34]) and the low WM group and the high WM group (p<.05, 95% CI [.11, 1.97]). The state frustration scores measured at all three time points are reported below in Table 4.16. It is

interesting to see frustration being reported by the same group across two different measures. The reasons why participants in some groups reported higher levels of frustration and task frustration are considered in the discussion at the end of this chapter.

Table 4.16: Mean scores on the anger/frustration subscale of the UWIST mood state scale reported after task 1 and 2 for the four participant groups

UWIST Anger / Frustration subscale score	Experimental condition	Mean	Std. Deviation	Std. Error Mean
Baseline	Low WM	6.04	1.84	.25
	High WM	6.46	1.83	.25
	No Distraction	6.33	2.29	.34
	Distraction	6.22	2.11	.31
After Task 1	Low WM	5.87	1.25	.17
	High WM	6.90	2.23	.31
	No Distraction	7.11	2.61	.38
	Distraction	7.26	2.72	.40
After task 2	Low WM	5.71	1.22	.17
	High WM	6.69	2.27	.31
	No Distraction	6.85	2.62	.38
	Distraction	6.72	2.89	.43

Subjective states

Differences between the low WM and distraction groups' mood states have already been noted as the distraction group reported significantly higher MWL, task frustration (one aspect of MWL) and general frustration. The mood state and other subjective state data was explored further to see if similar patterns to those reported by previous researchers (e.g. Hockey, 1997, see Chapter 2) could be found in this study. To do this, the change in subjective states was calculated between task 1 and baseline and task 2 and baseline (so that subjective state profiles could be compared for each of the 4 experimental groups (distraction, no distraction, high and low WM) and the subjective state changes caused by the tasks could be compared (rather than subjective states that participants were experiencing when they first arrived to take part in the study). The change scores therefore represent how subjective states changed after completing the first and second task.

These change scores were then compared using a two-way repeated measures ANOVA, with experimental group and participant type (student and CP) as independent variables, and subjective mood state change scores (for the UWIST, Motivation, Thinking style and Thinking content questionnaires in the DSSQ) as the dependent variables. For this analysis the change scores for task 1 and task 2 for each subjective state subscale reported are mean change scores (across the 2 tasks).

A significant difference between the experimental groups was found for 5 of the subjective state scales: hedonic tone ($F(3, 170)=2.79$, $p<.05$), anger and frustration ($F(3, 170)=2.87$, $p<.05$), success motivation ($F(3, 170)=3.10$, $p<.05$), self-focussed attention ($F(3, 170)=3.15$, $p<.05$) and concentration ($F(3, 170)=3.28$, $p<.05$). Figure 4.3 below shows the pattern of changes for 5 of the subjective state subscales
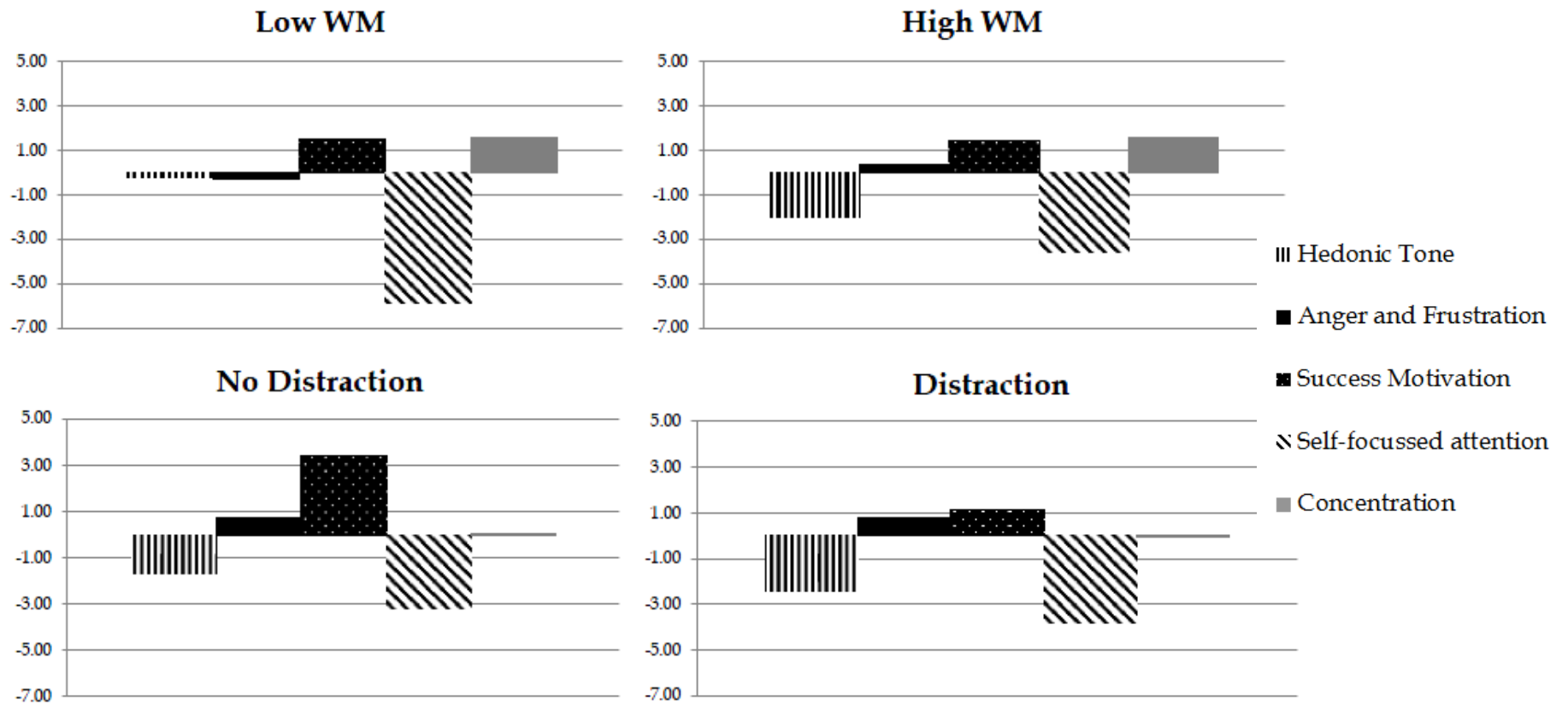
Figure 4.3: Bar graphs showing the mean changes in subjective states scores (for task 1 and 2) for the five subscales which showed significant changes during the study

Hedonic tone

Overall, participants in all four experimental groups showed a decrease in hedonic tone scores after task 1 and task 2 compared to baseline. The distraction group's hedonic tone scores decreased the most during the task and post-hoc LSD analyses showed that the significant difference in hedonic tone change scores was between the distraction and low WM load group's (p<.05, 95% CI [.42, 3.64]). The distraction group's hedonic tone score decreased by 2.06 more points than the low WM group's. There was also a significant difference between the high and low WM load groups' hedonic tone change scores (p<.05, 95% CI [.16, 3.35]). The high WM load group's hedonic tone change scores decreased 1.76 more than the low WM load group's. Decreased hedonic tone on the UWIST scale is related to increased task distress (Matthews, et al., 2002).

Anger and frustration

An increase in anger and frustration scores after the accuracy checking tasks was seen for three of the four groups (high WM load, distraction and no distraction). The low WM load group's reported anger and frustration levels decreased from baseline following completion of the accuracy checking tasks. A post-hoc LSD analysis showed that there was a significant difference in the change scores between the low WM group and no distraction group (p<.05, 95%CI [-1.73, -.13]) and between the low WM load group and the distraction group (p<.05, 95% CI [-1.74, -.18]). Anger and frustration scores increased by 0.93 for the no distraction group compared to the low WM load group, and by 0.96 for the distraction compared to the low WM load group. Increased anger and frustration scores on the DSSQ are related to increases in task related worry and distress (Matthews, et al., 2002).

Success motivation

Success motivation scores (wanting to succeed at the task) were seen to increase from baseline during the study for all 4 groups of participants. Increased success (and intrinsic) motivation are markers of increased task

engagement (Matthews, et al., 2002). A post-hoc LSD analysis found that the differences between the groups lay between the no distraction group and the distraction group (p<.01, 95% CI[-3.86, -.62]). The no distraction group's success motivation scores increased by 2.24 more than the distraction group's scores did. A significant difference was also found between the no distraction and high WM load groups (p<.05, 95%CI[.02, .25]). The no distraction group's success motivation scores increased by 1.86 points more than the high WM load group's score. The no distraction group also showed a significantly different increase in their success motivation scores compared to the low WM load group [p<.05, 95%CI [.03, .22]). The no distraction group's success motivation scores increased by 1.80 points more than the low WM load group's.

Self-focussed attention

Self-focussed attention scores decreased from baseline for all 4 groups of participants. It decreased the most for the low WM load group and this decrease in scores was found, by a post hoc LSD analysis, to be significantly different to the high WM load group (p<.05, 95% CI[-4.07, -.38]). The low WM load group's self-focussed attention scores decreased by 2.23 more than the high WM load group's scores. There was also a significant difference between the low WM load group and the no distraction group (p<.05, 95%CI [-4.18, -.37]). The low WM load group's self-focussed attention scores decreased by 2.27 points more than the no distraction group's.

Concentration

Concentration scores increased from baseline for all groups (although this can only be clearly seen on Figure 4.3 for the distraction and no distraction group). There was a significant difference between the no distraction group and the low WM load group in their levels of concentration reported after task 1 and 2 (p<.05, 95%CI[.12,2.96]) and the no distraction group and the high WM load group (p<.05, 95%CI[.16,2.93]). The low WM load group's concentration scores increased by 1.54 points more than the

no distraction group's scores. The high WM load group's concentration score increased by 1.46 more compared to the no distraction group's. There was also a significant difference between the distraction and low WM load group's concentration scores after tasks 1 and 2 (p<.05, 95% CI[-2.93, -.16]) and the distraction and high WM load group's concentration scores after tasks 1 and 2 (p<.05, 95% CI[-2.88, -.05]). The high WM load group's concentration scores increased by 1.47 points more than the distraction group's, and the low WM group's concentration scores increased by 1.55 points compared to the distraction group's. Increases in concentration are a marker of increased task engagement (Matthews, et al., 2002).

The number and types of dispensing errors missed

The average hit rate (correctly detected DEs) for tasks 1 and 2, and for both experiments 1 and 2 for CP participants was 82.63% (*SD*=15.70). The pharmacy students achieved an average hit rate of 75.70% (*SD*=18.92). Many participants in the two experiments therefore failed to detect all the DEs in the set of 50 dispensed items. As can be seen in Figure 4.4 below, only 35% of the CP participants and 25% of the pharmacy student participants detected all the DEs. A difference was observed between the pharmacy student and CP participants (from experiments 1 and 2) in the types of DEs that they detected. Tables 4.17 and 4.18 below report the frequency with which each DE was missed by the pharmacy student and CP participants. As items were randomised for the task and as there was a slightly bigger pool of items, not every DE was used every time. The percentage of participants who missed that DE is therefore calculated in relation to the number of times it was checked. The DEs most frequently missed by pharmacy student or community pharmacist participants sit at the top of the table and those never missed or rarely missed sit at the bottom of each table. It can be seen from tables 4.17 and 4.18 that CP participants mainly missed labelling errors. Unlike the CP participants the pharmacy student participants missed labelling and content errors (something wrong with the product) with almost equal frequency.

Table 4.17: The dispensing errors, how often they were missed and the types of dispensing errors missed by community pharmacists

Item no	Type of error (Content/Label)	What the error was	Missed (%)	Number of times checked
37	Label	Wrong drug name on label	50	42
9	Label	Wrong quantity on label	47	38
54	Label	Wrong drug name on label	44	43
55	Label	Wrong patient name on label	36	14
35	Label	Wrong directions on label	30	40
41	Label	Wrong strength on label	18	50
34	Content	Wrong formulation dispensed	7	44
2	Content	Wrong quantity dispensed	7	42
22	Content	Wrong quantity dispensed	4	48
10	Content	Wrong drug dispensed	3	59
48	Content	Wrong drug dispensed	0	45
11	Content	Wrong strength dispensed	0	53

Table 4.18: The dispensing errors, how often they were missed and the types of dispensing errors missed by the pharmacy student participants

Item no	Type of error (Content/Label)	What the error actually was	Missed (%)	Number of times checked
35	Label	Wrong directions on label	96	26
48	Content	Wrong drug dispensed	85	34
54	Label	Wrong drug name on label	53	36
55	Label	Wrong patient name on label	38	26
22	Content	Wrong quantity dispensed	28	36
37	Label	Wrong drug name on label	26	35
34	Content	Wrong formulation dispensed	17	35
10	Content	Wrong drug dispensed	11	46
9	Label	Wrong quantity on label	8	38
41	Label	Wrong strength on label	7	42
11	Content	Wrong strength dispensed	6	34
2	Content	Wrong quantity dispensed	5	39

Community pharmacist dispensing error detection

Pharmacy student dispensing error detection
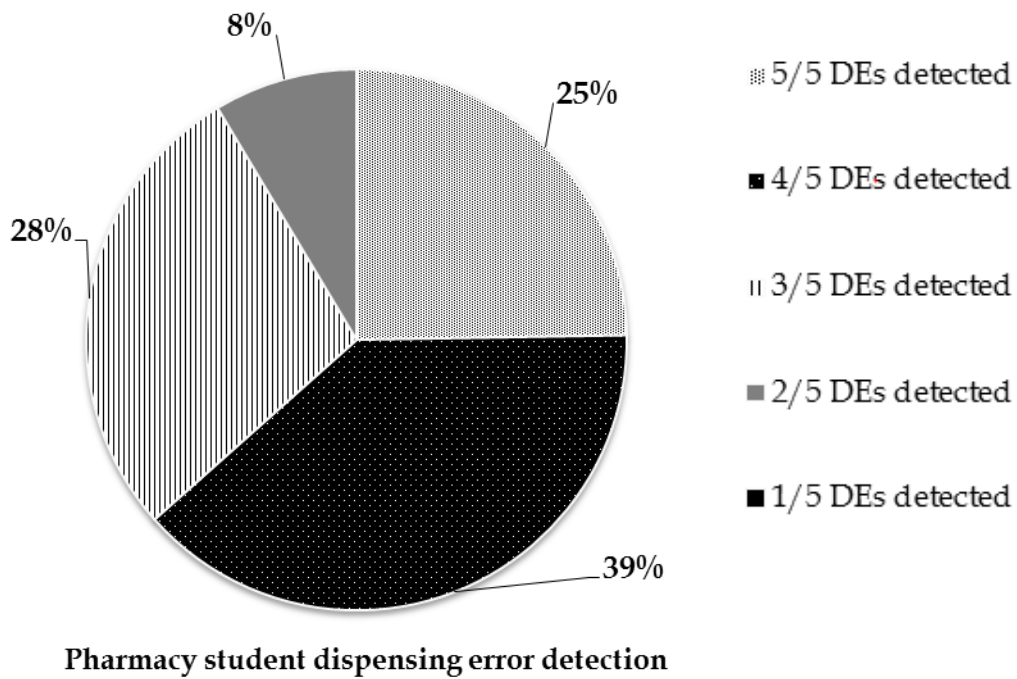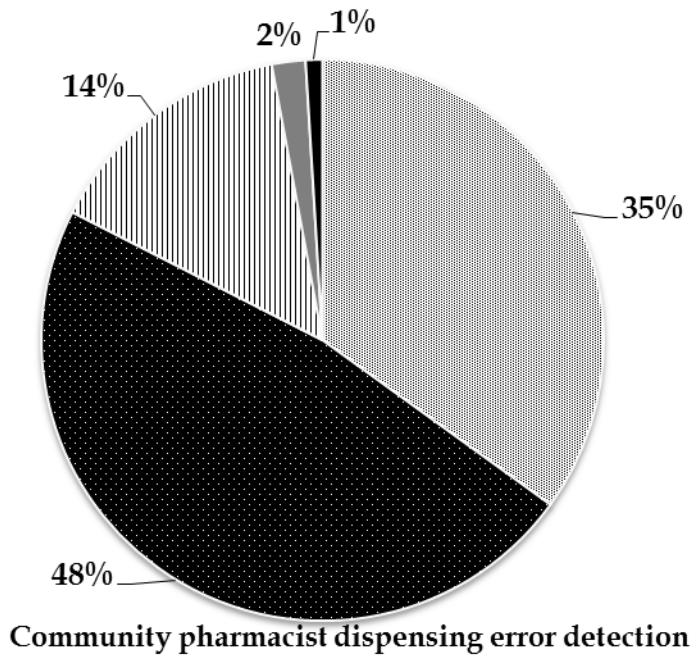
Figure 4.4: Pie charts showing the numbers of dispensing errors detected by community pharmacists and pharmacy student participants
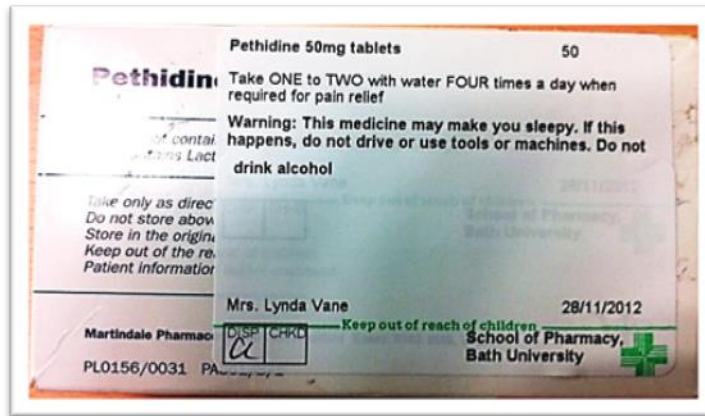
Figure 4.5: (see above) Photograph of item number 35 with the erroneous label

Figure 4.6: Photograph of the prescription for item number 35

Many of the labelling errors missed by CPs would not have resulted in patient harm but the error on item 35 was missed by 30% of the CPs who checked it. This is a concern as this product was a controlled drug, pethidine 50mg. The error for this item was in the directions on the label. The directions on the prescription were for 1-2 tablets every 4 hours, but the label directions read 1-2 four times a day (see Figures 4.5 and 4.6 above for pictures of the prescription and labelled item). Item 35 was also the DE most frequently missed by pharmacy students, with 96% of the pharmacy students who checked it failing to detect the erroneous directions.

Differences between participants who detected all the errors and those who did not

The reasons why only 35% of the pharmacist participants and 25% of pharmacy student participants in experiment 1 and 2 detected all the DEs were explored. The data from experiments 1 and 2 were pooled and the dataset was split into two new groups according to whether participants had detected all 5 errors (n=59), or not (n=138).

Descriptive statistics were produced and several variables were identified which appeared to be different between the two groups and were selected for statistical analysis. These variables were the amount of community pharmacy experience and amount of pharmacy experience (in all settings), the amount of time since their last pharmacy shift, self-reported levels of the personality trait conscientiousness and the criterion and d' values for the whole task (tasks 1 and 2 combined). The descriptive data can be seen in Table 4.19 below.

A correlation matrix of the identified variables and overall hit rates was produced to see if any of these variables were related to hit rates. Three of the variables were correlated with hit rates - amount of time since last pharmacy shift (r =-.24, p< .001), the overall criterion value (r = -.69, p <.001) and the d' value (r = .70, p<.001).

Table 4.19: Mean scores for the variables that were different between the participants who detected all the dispensing errors and those who did not

Variable	Error detection group	Participant group	Mean	S.D.
Amount of community pharmacy experience (weeks)	Did not detect all the errors	CP	672.24	568.75
		Student	18.99	23.77
	Detected all the errors	CP	724.39	573.62
		Student	44.17	59.05
Amount of pharmacy (all types) experience (weeks)	Did not detect all the errors	CP	759.99	601.44
		Student	26.11	36.24
	Detected all the errors	CP	804.92	604.76
		Student	47.63	58.19
Amount of time since last pharmacy shift (weeks)	Did not detect all the errors	CP	.43	1.50
		Student	154.15	179.35
	Detected all the errors	CP	.96	2.72
		Student	82.43	111.92
Criterion value for tasks 1 and 2	Did not detect all the errors	CP	.53	.30
		Student	.64	.32
	Detected all the errors	CP	.24	.24
		Student	.25	.20
d' value for tasks 1 and 2	Did not detect all the errors	CP	2.36	.59
		Student	2.28	.62
	Detected all the errors	CP	3.05	.48
		Student	3.09	.40
Conscientiousness	Did not detect all the errors	CP	3.90	.55
		Student	3.68	.56
	Detected all the errors	CP	3.99	.51
		Student	3.95	.49

Next, independent t-tests[13] were carried out to identify whether these variables significantly differed between the participants who did detect all the DEs and those who did not. The t-tests indicated that there was no significant difference between the participants who detected all the DEs and those who did not in the amount of experience they had in a community pharmacy setting, or all types of pharmacy setting. There was

---

[13] Independent t-tests were used to compare the two groups in their amount of community pharmacy experience, other pharmacy sector experience and time since last shift instead of two-way ANOVAs because these were variables that CPs and pharmacy students are expected to differ and so no test was needed to measure the differences between the pharmacy students and CPs at the same time.

a significant difference between the groups in the time since the participants' last shift ($t(181)$ = -2.34, p<.01). Participants who detected all the DEs had worked a shift in a community pharmacy more recently. Although Table 4.19 above shows this recency effect is mainly amongst the pharmacy students.

A two-way independent ANOVA was carried out with detection of DEs and whether participants were pharmacy students or CPs as independent variables and conscientiousness as the dependent variable. This analysis found that there was a significant difference in self-reported conscientiousness between participants who detected all the DEs and those who did not ($F(1,193)$=4.60, p<.05). However there was no main effect of pharmacy expertise (i.e. whether the participant was a student or CP). Participants who detected all the DEs rated themselves as more conscientious.

Another two-way independent ANOVA was carried out comparing response criterion values (dependent variable) between the participants who detected all the DEs and those who did not (independent variable 1), with pharmacy qualification as the second independent variable. A significant difference was found in response criterion values between participants who detected all the DEs and those who did not ($F(1,193)$=54.49, p<.001). However, there was no difference between the CP and pharmacy student participants' response criterions. The criterion value for participants who detected all the DEs was lower meaning that they had a more liberal response criterion compared to participants who failed to detect all the DEs.

One final two-way ANOVA was carried out to compare d' values for these two groups, and to test whether d' values varied if the participant was a CP or pharmacy student participant. A significant difference in d' scores was found between participants who detected all the DEs and those who did not ($F(1,193)$=70.91, p<.001). No significant difference was found between pharmacy student and CP participants in these groups.

Participants who detected all the DEs were found to have a higher d' value which indicates greater perceptual sensitivity to the signal.

Independent samples t-test were carried out to identify whether participants whose first language was not English had different hit or false alarm rates, d' or c index scores. For 42 of the participants in this study, English was not their first language, however no difference was found in hit or false alarm rates, d' or criteria values when they were compared to participants who reported that English was their first language. A further independent samples t-test was carried out to compare the time it took participants whose first language was not English to complete the task. It was found that participants whose first language was not English took significantly longer on average (50.28 minutes) compared to participants whose first language was English (46.93 minutes) (t(195)=2.20, p<.05).

The difference in hit rates between tasks 1 and 2
When examining the hit rates for the pharmacy students and the CPs for task 1 and task 2, an interesting pattern was observed. Pharmacy students' performance increased between task 1 and 2 whereas CPs performance decreased between task 1 and 2.

The hit and false alarm rates, response criterion and d' values for task 1 and 2 (see Table 4.20 below) were compared for pharmacy students and CPs using repeated measures t-tests. The pharmacy student and CP data were analysed separately. A significant difference in hit rates for task 1 and task 2 was found for CP participants (t(103)=2.80, p <.01, r =.27) and for pharmacy students (t (92) = -2.21, p<.05, r = .22). These differences confirm the trends observed, that pharmacy students' hit rates significantly increased and community pharmacists hit rates significantly decreased between task 1 and task 2. False alarm rates were compared between task 1 and 2 for both groups of participants using repeated measures t-tests to see if these rates also differed between tasks 1 and 2. No significant difference was found in false alarm rates between task 1 and 2 for the CP or pharmacy student participants.

Table 4.20: Hit and false alarm rates, d′ and criteria values and the time taken to complete the task (for all participants in experiment 1 and 2) for task 1 compared to task 2

Variable	Participant Group	Task	Mean	Std. Deviation	Std. Error Mean
Hit rates	CP	Task 1	87.02	19.00	1.86
		Task 2	77.72	27.64	2.71
	Student	Task 1	72.13	26.28	2.73
		Task 2	80.11	24.85	2.58
False alarm rates	CP	Task 1	6.98	8.49	.83
		Task 2	5.06	9.00	.88
	Student	Task 1	5.10	6.70	.69
		Task 2	4.69	6.74	.70
d′	CP	Task 1	2.18	.59	.06
		Task 2	2.23	.64	.06
	Student	Task 1	2.10	.60	.06
		Task 2	2.20	.63	.07
Criterion	CP	Task 1	.46	.32	.03
		Task 2	.61	.27	.03
	Student	Task 1	.62	.31	.03
		Task 2	.60	.27	.03
Time taken to complete the task	CP	Task 1	24.12	5.15	.50
		Task 2	21.23	4.93	.48
	Student	Task 1	25.94	4.04	.42
		Task 2	24.56	2.99	.31

A repeated measures t-test showed a significant change in CP participants response criterion between task 1 and 2 ($t(103)$ = -4.12, p<.001, r =.38), but no significant difference was found in the response criterion for pharmacy student participants. In this study the CPs' criterion increased between task 1 and 2 meaning that these participants were adopting a more conservative criterion (i.e. they required more evidence before they would report a DE).

The mean d′ values for all participants in experiment 1 and 2 were calculated for task 1 and task 2. Repeated measures t-tests showed no change in d′ between task 1 and 2 for the CP or pharmacy student participants.

One factor that may explain a difference in performance for the pharmacy students and CPs between task 1 and task 2 is the time taken to complete the two tasks. Table 4.20 above reports the mean time taken for the two different groups of participants to complete task 1 compared to task 2. Repeated measures t-test showed that there was a significant difference in the time taken to complete task 1 compared to task 2 for both the community pharmacist participants (t(103)=8.87, p<.001, r=.66) and pharmacy student participants (t(92)=4.59, p<.001, r=.43).

Mental workload changes between tasks 1 and 2

The MWL scores for all CPs and pharmacy student participants who took part in experiment 1 or 2 were calculated and the MWL scores for task 1 and task 2 were compared using repeated measures t-tests (t-tests were carried out on student and CP data separately). Table 4.21 below reports the results of the repeated measures t-tests and the mean scores for each item of the MWL scale between tasks 1 and 2 for the pharmacy student participants. Significant differences were found between NASA-TLX scores for tasks 1 and 2 for all but one item of the NASA-TLX scale. The effort scores did not significantly differ between task 1 and task 2. As can be seen from Table 4.21 below the mental and physical demand levels that student participants reported significantly increased between tasks 1 and 2. Whereas the reports of performance, task frustration, temporal demand and overall MWL significantly decreased between task 1 and 2.

The CP participant results are reported in Table 4.22 below. The repeated measures t-tests showed that temporal demand reports decreased and the physical demand reports increased significantly between task 1 and 2. The results of the repeated measures t-tests can be seen in Table 4.22 below

Table 4.21: Mean NASA-TLX item scores for tasks 1 and 2 for all pharmacy student participants and results of repeated measures t-tests

NASA-TLX item	Task	Mean	S.D.	Std. Error Mean	t (df)	p	r	Direction of change
Mental demand	1	7.27	1.48	.15	-4.38 (92)	p<.001	.42	↑
	2	7.68	1.38	.14				
Physical demand	1	2.57	2.14	.22	-2.61 (92)	p<.05	.26	↑
	2	2.95	2.36	.25				
Temporal demand	1	7.18	2.02	.21	3.29 (92)	p<.001	.32	↓
	2	6.54	2.39	.25				
Performance	1	3.72	1.77	.18	3.01 (92)	p<.01	.30	↓
	2	3.30	1.47	.15				
Effort	1	7.29	1.29	.13	-.32 (92)	No significant change		
	2	7.33	1.51	.16				
Task Frustration	1	3.59	2.34	.24	3.66 (92)	p<.001	.36	↓
	2	2.77	2.13	.22				
Overall Mental Workload Score	1	5.27	1.11	.12	2.12 (92)	p<.05	.22	↓
	2	5.10	1.17	.12				

Table 4.22: Mean NASA-TLX item scores for tasks 1 and 2 for all community pharmacist participants and results of repeated measures t-tests

NASA-TLX item	Task	Mean	S.D.	Std. Error Mean	t (df)	p	R	Direction of change
Mental demand	1	7.67	1.58	.16	.53 (103)	No significant change		
	2	7.61	1.75	.17				
Physical demand	1	2.41	1.94	.19	-2.06 (103)	p<.05	.20	↑
	2	2.63	2.15	.21				
Temporal demand	1	6.34	2.49	.24	2.25 (103)	p<.05	.22	↓
	2	5.82	2.64	.26				
Performance	1	2.16	1.64	.16	1.76 (103)	No significant change		
	2	1.97	1.36	.13				
Effort	1	7.03	1.80	.18	.13 (103)	No significant change		
	2	7.01	1.74	.17				
Task Frustration	1	3.02	2.66	.26	.67 (103)	No significant change		
	2	2.85	2.48	.24				
Overall Mental Workload Score	1	4.77	1.24	.12	1.26 (103)	No significant change		
	2	4.65	1.27	.12				

A correlation matrix was produced to identify whether there were any relationships between hit rates for task 1, 2 and overall with the NASA-TLX MWL item scores (for task 1 and 2) or the other DSSQ subjective state subscale scores (at baseline, tasks 1 and 2). None of the DSSQ subscale

scores correlated with hit rates during the study. However, three of the NASA-TLX items did correlate with hit rates, but only for task 1. These were temporal demand, performance concern and overall MWL scores reported after task 1. It is interesting that pharmacy student scores on these three measures reduced between task 1 and 2, and that between the two tasks pharmacy students hit rates also increased.

To explore this finding further the pharmacy student data was coded to identify participants who had scored higher or lower than the median value for temporal demand, performance concern and overall MWL for task 1. The hit rates achieved by pharmacy student participants who had reported overall MWL scores higher than the median value (5.33) were compared with participants whose scores were lower than the median value. It was found that pharmacy students who reported MWL scores of 5.33 or higher after task 1 missed significantly more DEs in task 1 than students who had reported lower MWL scores. However no significant difference was found for hit rates achieved in task 2 or overall. When the pharmacy students were compared according to their temporal demand scores, and their performance concern scores no significant difference was found in hit rates at task 1, 2 or overall.

To test the relationship between hit rates and these three variables, the pharmacy student data was coded according to whether students had rated higher or lower than the median scores for these three variables. The median scores were: temporal demand (task 1) = 8.00, performance concern (task 1) = 3.00 and overall MWL (task 1) =5.33. An independent samples t-test was run for hit rates for task 1, 2 and overall hit rates, with overall MWL as the independent variable. Pharmacy students who scored 5.33 or higher for overall MWL missed significantly more DEs in task 1 than pharmacy students who scored lower than 5.33 (t(91)=1.99, p<.05). Pharmacy students who reported their overall MWL to be 5.33 or higher achieved a mean hit rate of 66.84% (*s.d=27.83)* in task 1. Pharmacy students who reported their overall MWL to be lower than 5.33 achieved a mean hit

rate of 77.54% (*s.d=23.69)* in task 2. No significant difference in hit rates was found for task 2 or overall hit rates. No significant difference in hit rates was found when independent samples t-tests compared pharmacy student participants who had reported above or below the median temporal demand or performance concern scores for task 1.

CP participants' hit rates were also compared according to whether CPs had reported higher or lower than the median MWL score (5.00). Hit rates did not differ between participants whose overall MWL was higher than the median (5.00) compared with those who reported their overall MWL to be lower than the median.

Subjective state changes between tasks 1 and 2

Changes in subjective states (other than MWL) between tasks 1 and 2 were explored (with the CP sample) following several comments from CPs in the qualitative study of MWL carried out for study 3 (see Chapter 6). These quotes highlighted that CPs felt they needed to be "in the zone" (to have high mental focus) in order to carry out their work safely. Tasks which CPs reported were hard to stay "in the zone" for included easy and repetitive tasks. It may be that CPs hit rates declined between tasks 1 and 2 because they became less engaged in the accuracy checking task (because it was fairly repetitive).

Three subscales from the mood state scale (energetic arousal, tense arousal and hedonic tone), both the motivation subscales, the task irrelevant interference subscale and concentration subscale of the DSSQ are related to task engagement. Repeated measures t-tests compared scores on these subscales after task 1 and after task 2 (for the CP participants only). Significant differences in scores reported after task 1 and 2 were found for all these subscales except hedonic tone. The results of these analyses can be seen in Table 4.23 below. The graphs in Figure 4.7 below also show that the patterns of changes in these subjective states were different for pharmacy students and CPs.

The CPs' scores on these subscales (measured at baseline, after tasks 1 and 2) were correlated with their hit rates, response criteria and d' values, to find out if changes in these scores may be related to reduced hit rates, or changes in their response criteria and perceptual sensitivity between tasks 1 and 2. Tense arousal scores measured after task 1 were significantly correlated with hit rates in task 1 (*r*=.20, p<.05) but tense arousal was not correlated with hit rates for task 2. No other variables correlated with hit rates. Success motivation measured after task 2 was found to be significantly correlated with criteria scores for task 2 (*r*=.26, p<.01). Energetic arousal scores after task 1 were found to have a significant,

Table 4.23: CP participant's mean scores (reported after tasks 1 and 2) on subjective state subscales related to task engagement, and the results of repeated measures t-tests which assessed the differences in these scores between tasks 1 and 2.

Subjective state subscale	Task	Mean	S.D	Std. Error Mean	*t* (d.f.)	*P*	*r*
Energetic arousal	1	26.96	3.47	.34	3.25 (103)	p<.01	.30
	2	26.05	4.11	.40			
Tense arousal	1	18.13	4.73	.47	5.23 (101)	p<.001	.46
	2	16.07	4.73	.47			
Hedonic Tone	1	27.27	3.66	.36	-1.97 (102)	Not significant	
	2	28.23	5.64	.56			
Success Motivation	1	18.88	5.83	.57	2.28 (103)	p<.05	.22
	2	18.08	6.64	.65			
Intrinsic Motivation	1	22.24	4.41	.43	2.36 (102)	p<.05	.23
	2	21.53	5.16	.51			
Task irrelevant interference	1	9.49	3.14	.31	-2.99 (102)	p<.01	.28
	2	10.27	3.92	.39			
Concentration	1	25.50	4.06	.40	3.95 (103)	p<.001	.36
	2	24.11	4.79	.47			

Key: ■CPs   ■Pharmacy students
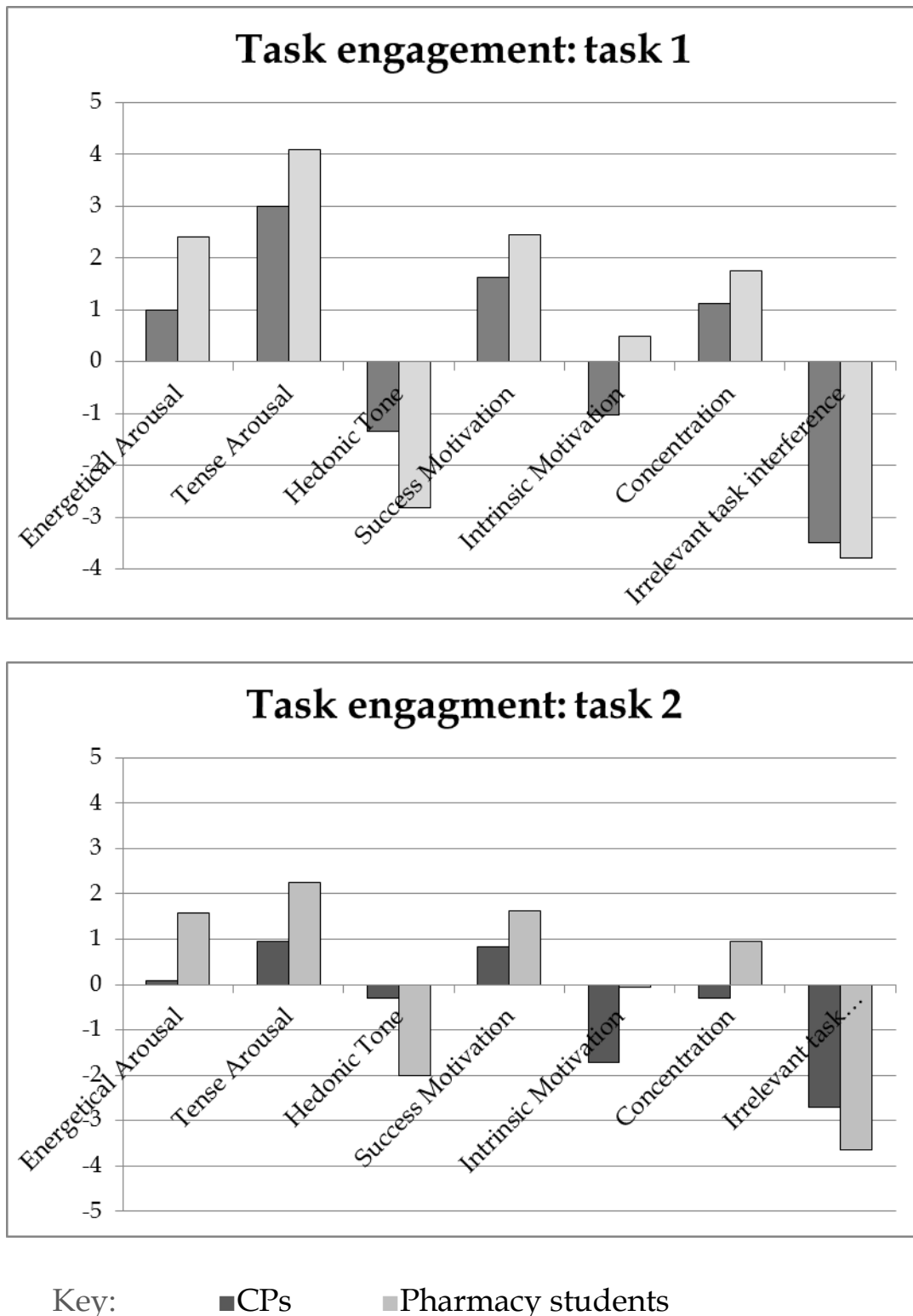
Figure 4.7. Bar charts showing the change scores for the subjective states related to task engagement for CPs compared to pharmacy students

negative correlation with response criteria scores after task 1 (r= -.22, p<.05).This correlation means that participants who reported higher levels of energetic arousal were likely to have a lower response criteria value (which indicates a trend towards a more liberal response criteria). However, energetic arousal scores for task 2 were also significantly, negatively correlated with d′ scores for task 2 (r= -.21, p<.05). Energetic arousal scores after task 1 (r= -.25, p<.05), and task 2 (r= -.21, p<.05) were significantly, negatively correlated with the d′ value (for overall task performance). These correlations mean that as energetic arousal increased, perceptual sensitivity decreased (as higher values of d′ indicate greater perceptual sensitivity to stimuli). The correlations present conflicting, but some initial evidence that CPs whose task engagement dropped and may have contributed towards a decrease in hit rates, through affecting participant's response criterion which was found to significantly change between tasks 1 and 2 for the CP participants.

4.3.5. Summary of findings

Findings relating to dispensing error detection

- The addition of a six two-digit number memory task (high WM load) did not affect pharmacy student or CP participants' detection of DEs in experiment 1.
- The participants who were distracted and interrupted whilst carrying out the accuracy checking tasks did not show any difference in DE detection rates compared to participants who were not interrupted and distracted.
- No significant difference was found when the hit rates achieved by the four groups of participants in experiments 1 and 2 (high and low WM, distraction and no distraction) were compared.
- Pharmacy students achieved significantly lower hit rates than CPs in experiment 1, but not experiment 2.
- Pharmacy students in experiment 1 were found to have significantly lower perceptual sensitivity than CPs.

- Pharmacy students in experiment 2 showed a significantly more liberal response criterion (needing less evidence before they said a DE was present) compared to the CPs in this experiment.

- Pharmacy students hit rates ranged between 69 – 82% and CP hit rates ranged from 75-89%

- Pharmacy students hit rates increased between task 1 and 2, but CPs' hit rates decreased between the two tasks. A significant shift to a more conservative response criterion was seen in the CP data. A similar shift was not observed in the student data. Some initial evidence was found to suggest that the shift in the CPs' response criteria may be related to reduced engagement in the accuracy checking task.

- Pharmacy students (in experiment 1 and 2) who reported overall MWL scores of 5.33 or higher for task 1 missed significantly more DEs in task 1 than those who reported lower overall MWL scores. This relationship was not seen in task 2 as overall MWL scores significantly decreased between task 1 and 2 for the pharmacy student participants.

- Only 35% of the CP and 25% of the pharmacy student participants (for experiments 1 and 2) detected all the DEs. CPs were more likely to miss labelling errors than content errors (errors with the medicine), pharmacy students missed labelling and content errors in equal amounts.

- Participants (pharmacy students and CPs) who detected all the DEs in tasks 1 and 2 were compared with participants who did not. Participants who detected all the DEs had worked a shift in a community pharmacy more recently, had higher levels of trait conscientiousness, had greater perceptual sensitivity to DEs and had a more liberal response criterion.

Findings related to mental workload

- Pharmacy students reported significantly higher overall MWL scores compared to CPs in experiment 1 but not experiment 2.

- Experiment 1 participants in the high WM load group reported significantly higher task frustration compared to the low WM load group after task 2.

- The distraction and low WM load groups from experiments 1 and 2 reported significantly different task frustration scores (one aspect of MWL) after task 1 and 2. The participants who were in the distraction and interruption group reported higher task frustration after both tasks.

- The distraction and low WM load groups were also found to have significantly different overall MWL scores after task 2. With the distraction group reporting higher overall MWL.

- Pharmacy students (in both experiments 1 and 2) overall MWL and the individual aspects of MWL varied significantly between task 1 and 2. Students reported increased mental and physical demand for task 2 compared to task 1. However they reported decreased temporal demand, performance concern, task frustration and overall MWL for task 2 compared to task 1. Significant, negative correlations were found between task 1 hit rates and temporal demand, performance concern and overall MWL.

- CPs (in both experiments 1 and 2) reported significantly higher physical demand after task 2 compared to task 1 and significantly lower temporal demand after task 2 compared to task 1.

Findings related to other subjective states

- Unlike MWL, the other subjective mood states (or transient individual difference factors) were not related to DE detection in this study.

- Some significant mood state changes from baseline (before task 1) were observed between the four groups of participants in

experiments 1 and 2, indicating a possible effect of the task manipulations on mood states.

- Hedonic tone decreased for all groups of participants, decreases in hedonic tone is one of several mood state changes proposed by Matthews et al to be associated with Hockey's overload mode of control (Hockey, 1997; Matthews, et al., 2002). Participants in the distraction group showed the largest decrease in hedonic tone scores, and this was significantly different to the low WM load group score which showed the smallest decrease.

- All four groups of participants also showed a decrease in self-focussed attention which is also related to Hockey's overload mode of control. The low WM load group's self-focussed attention decreased the most.

- The low WM load group showed a decrease in the subscale which measured state anger and frustration, however the three other groups showed an increase in anger and frustration scores. The distraction group showed the biggest increase in anger and frustration scores and this was significantly different to the low WM load group.

- Increases in concentration and success motivation were seen for all groups. Increases on these subscales are thought to be related to increased task engagement (Matthews, et al., 2002). The distraction group showed the smallest increases in these scales compared to the other 3 groups.

4.3.6. Discussion of results

This chapter has presented the findings of two experimental studies into the impact of MWL on CPs' and pharmacy students' ability to detect DEs when carrying out a final accuracy check. The aims and objectives of this study were 1) to measure MW whilst CPs carried out a final accuracy check under controlled conditions, and 2) to purposefully vary aspects of the task and the simulated pharmacy environment to identify whether this impacted on participants MWL and/or their ability to detect DEs. A

further aim was to measure the impact of individual difference factors on pharmacy students and CPs' ability to carry out a final accuracy check and on their experiences of MWL. The aim of these experiments was also to measure the difference between expert and novice pharmacists in their detection of DEs and the levels of MWL they experienced when carrying out a final accuracy check task.

Detection of dispensing errors

Only 25% of the pharmacy students and 35% of the CPs detected all the DEs. The mean hit rates for these two groups ranged between 69-82% for the pharmacy students and 75-89% for the CPs. The hit rates observed for the pharmacy student participants and CPs closely resemble those observed by James et al (2010) in their accuracy checking study. They are also in quite close agreement with the findings of the simulated accuracy checking studies carried out by Reilley et al (2003; 2002), where the hit rates ranged between 66-84% and 65-98%. The studies by James et al (2010) did not control for signal probability and the two studies carried out by Reilley et al (2003; 2002) used higher signal probabilities than used in this study. This suggests that signal probability may not be affecting DE detection rates as significantly as other factors. The other factors which may have affected DE detection are discussed below.

In experiment 1 pharmacy students were found to miss significantly more DEs than CPs. They were also found to have significantly lower d' (perceptual sensitivity) scores compared to CPs indicating that they were less able to perceive a DE when it occurred. This would be a logical finding as pharmacy students will not have been exposed to some medicines before and therefore they may not know that there are different formulations or strengths of the medicine when they encounter a new medicine. In experiment 2 there was no difference in hit rates between pharmacy students and CPs, and accordingly no difference was found in d' scores between these groups. However, a significant difference in the response criterion was found between the two groups. Pharmacy students

were observed to use a more conservative response criterion than CPs, which was most likely due to differences in false alarm rates as these values are used to calculate the response criterion. The d′ and response criterion values should be treated with some caution though as Schell et al (2005) note the stimuli in this task are complex. This means that the signal strength or signal intensity is difficult to measure and hold constant, and therefore the signal and noise distributions may not be normally distributed which could affect the results of these calculations (Schell, et al., 2005). This study found that labelling errors were missed more often by CPs than content DEs (errors relating to the wrong, type, amount, formulation of medicine). Pharmacy students missed both labelling and content errors with equal frequency. One possible reason why CPs were more successful in detecting content DEs compared to labelling errors may be related to the fact that more sensory information is provided by the packaging and feel of a medicine, compared to the information which is generated by the pharmacy label. Medicines packaging varies in colour, weight, size, text font and feel which potentially could provide multiple signals that a DEs has been made. The medicine labels will all be printed on the same stationary, using the same font, similar format and the same colours meaning that visual look and feel of labels will not vary as much as the packing and feel of medicines, providing less evidence that a DE has been made.

Reilley et al (2002) also found that participants in their study missed more labelling errors when there was less time available to carry out the task. When participants were asked to check 120 items in 120 minutes they missed significantly more labelling errors compared to participants who were asked to check 72 dispensed items in 120 minutes. However, the participants in this study were undergraduate psychologists so the checking task did not employ realistic prescriptions, or real medicines. It is interesting that the condition which allowed a minute per item, which is equivalent to the time provided in this doctoral study, led to significantly more labelling errors being missed. It has been found that hospital

pharmacists take on average 45 seconds to check a dispensed item (personal communication with Dr Lynette James, 10.6.2013) so a minute per item is a realistic amount of time to carry out this task.

Mental workload and dispensing errors

This study found that increased overall MWL (as measured by the NASA-TLX) was related to reduced DE detection but only for the pharmacy student participants (in experiments 1 and 2) and only for task 1 and not task 2. Overall MWL reported by students decreased between task 1 and 2 (from 5.27 to 5.10) and hit rates increased at the same time. Although the decrease in MWL was significant it represented quite small overall change as the values shown above show the difference between task 1 and task 2 scores was only 0.17 points. However the authors of the NASA-TLX suggest an overall MWL score of 5 or higher is indicative of a demanding task (Hart & Staveland, 1988; Matthews, et al., 2002). It is also important to note that the small change in overall MWL scores represents some larger changes in the individual items of the NASA-TLX scale. For example, performance concern and time pressure decreased, but effort and physical demand increased.

The overall MWL experienced by CPs was not related to DE rates. This may be because their MWL was lower than the pharmacy students (4.77 for task 1 and 4.65 for task 2). However, this difference between CP and pharmacy students' scores was only significant in experiment 1. No significant difference was found in overall MWL scores between pharmacy students and CPs in experiment 2. It is likely that CPs MWL was not related to DE detection because CPs and pharmacy students will have been using different levels of cognitive control to carry out the task. For example CPs would be expected to have more relevant knowledge stored in their long-term memory about the medicines they were checking. CPs would also probably have schema stored in LTM which they used to check the medicine and label against the prescriptions which the students may not have had. The difference in MWL scores between CPs and pharmacy

students and the difference in the relationship between MWL and DEs found in experiments 1 and 2 highlights the importance of studying work demands on representative populations.

The impact of an additional task on MWL and DE detection (experiment 1)

The participants in experiment 1 who were given 6 (2-digit) numbers to remember whilst carrying out the accuracy checking task (high WM load group) did not miss more DE or report higher MWL than participants who were asked to remember 1 (2-digit) number (low WM load group). On reflection these results may be due to the choice to use a memory load task that did not last for the duration of the checking task. The aim was to avoid creating a distracting event through asking participants to respond to a secondary task at regular intervals. However, many participants did not successfully recall all the numbers. This may be because they found the accuracy checking task too demanding to allow memory for the numbers too, so they purposefully shed the secondary task. They may also have failed to rehearse the numbers and so the memory traces decayed from WM before they could be encoded in LTM. However, they were given 30 seconds to view the numbers so this should have provided time for some rehearsal. This study illustrates an issue identified by Wickens et al (2013) that it is difficult to control the amount of attention participants pay to the secondary task.

Overall MWL scores also did not differ between the high and low WM load groups. However, task frustration (one aspect of MWL) reported after task 2 did differ between these two groups of participants in experiment 1. According to Hart and Staveland (1988) task frustration increases in tasks which are mentally demanding. This suggests that during task 2 participants in the high WM load condition may have experienced higher mental demands than the low WM load group. However the mental demand scores themselves were not significantly different between the two groups.

The impact of the pharmacy environment on DEs and MWL (experiment 2)

The participants who took part in the distracting and interrupting environment did not miss more DEs or report higher MWL compared to participants who took part in a quiet environment with no interruptions or distractions. The number of interruptions and distractions used in experiment 2 were based on previous research that found that pharmacists were interrupted on average six times an hour and distracted an average of six times an hour (Flynn, et al., 1999). Flyn et al (1999) observed the dispensing process as a whole and found that DE rates increased when more interruptions and distractions occurred. However this was an observational study of a working pharmacy and it may be that other confounding factors which were not measured in this research were contributing to the occurrence of DEs. It is also possible that interruptions and distractions do not affect accuracy checking processes but do reduce the safety of other aspects of the dispensing process. This idea is supported by a postal survey carried out by Chui et al (2011) who found that pharmacists reported that clinical checks and patient counselling were affected by interruptions and distractions but not accuracy checking practices.

Individual difference factors and accuracy checking performance

Previous research has linked some individual difference factors to accuracy checking performance. For example Schell and Reilley (2004) found that higher levels of trait conscientiousness and trait extroversion were related to superior performance at accuracy checking. A similar result was found in this doctoral study when data were pooled from experiments 1 and 2 and participants who detected all the DEs were compared with participants who did not detect all the DEs. Participants who detected all the DEs reported higher levels of trait conscientiousness, but not extroversion. Schell and Reilley (2004) also compared performance in relation to stable and shifting WL patterns (from low-to-high WL) and found that conscientiousness only predicted performance in stable WL

patterns. Participants in experiments 1 and 2 were tested under stable WL conditions so it is unknown whether conscientiousness would have predicted performance if participants experienced a change in WL in this study. It is also important to note that the study by Schell and Reilley (2004) illustrates how difficult it is to generalise the findings of an effect of personality on accuracy checking task performance, when personality only predicts performance under certain WL patterns. Another individual difference factor that predicted DE detection was how much time had elapsed since a participants' last shift in a community pharmacy. Participants who had had a shift more recently had superior DE detection rates. This is interesting as this may be particularly important for pharmacy students preparing themselves for their dispensing and checking examinations. Individual difference factors that did not predict hit rates in this study included age, gender, amount of pharmacy experience and first language.

4.4.   Summary of chapter 4

This chapter outlined the findings of two experimental studies into the relationship between MWL and accuracy checking performance under different task loads and environmental conditions. These experiments produced a number of results, which suggest that novice pharmacists' accuracy checking performance is more susceptible to MWL increases. However, novice and expert pharmacists' performance was not affected by additional task load or distractions and interruptions. This research also showed that expert pharmacists are most likely to miss labelling errors whereas novice pharmacists miss both labelling and content errors. These findings were compared to the results of previous research and some explanations for the findings were presented. The findings of the experimental phase of this research are discussed in chapter 7 in relation to the findings presented in chapters 5 and 6. Chapter 5 now presents the results of a diary study which measured CPs MWL throughout a shift in their pharmacy to explore the nature and effect of MWL at an individual level.

CHAPTER 5: MENTAL WORKLOAD DIARY STUDY
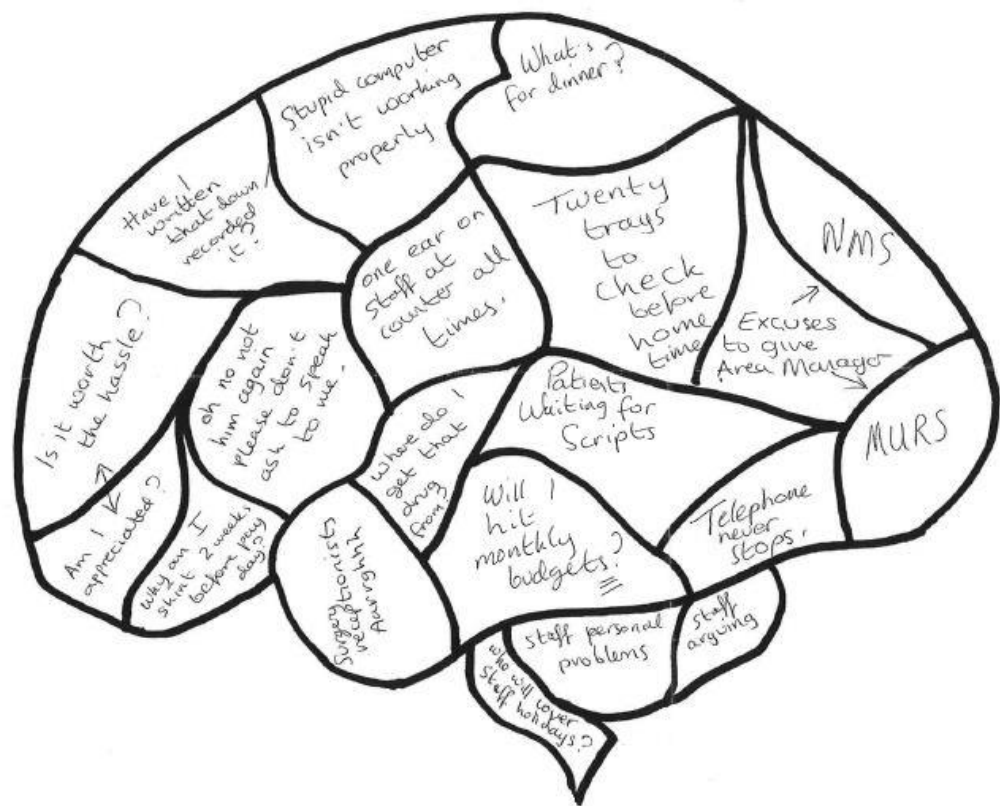
"Other pharmacies where I have worked in, where you have just got a constant bench of checking to do. You never quite feel like you get through the work and you can draw a line under it and leave it for the next [day] *because you've always got more pressures."*

Community Pharmacist 12

5.1. Chapter Outline

It is not known what levels of mental workload (MWL) UK community pharmacists (CPs) experience in their day to day work. This chapter presents the results of a diary study into the amount of MWL that a sample of CPs experienced during a day at work. Before the results of the diary study are presented the supporting literature, rationale and methods used for this diary study are outlined. The chapter ends with a discussion of the results in relation to the supporting literature.

5.2. Background

There is little published research on how much MWL pharmacists experience in their day to day work (as opposed to when in laboratory based pharmacy simulations). A large proportion of the available evidence is also based on hospital pharmacists' experiences of MWL (Gidman & Oppon-Agyapomaa, 2010; Holden et al., 2010) rather than CPs'. Whilst similar work is carried out by CPs and hospital pharmacists it may not be possible to generalise between these two sectors due to different staffing models and the amount of assistive technology (e.g. automated dispensing systems in hospitals). Although some initial evidence on CPs' MWL exists (Chui, Mott, & Rodriguez, 2011; Grasha, 2002a; 2002b) this research has been carried out in the USA. Grasha (2002b) and Gidman and Oppon-Agyapomaa (2010) both carried out studies of MWL where other aspects of workload (WL) (e.g. prescription volume, staffing) were measured at the same time. The results of these two studies provided and insight into how MWL related to objective (or volume-based) measures of WL. This insight had not been possible in the work carried out by Holden et al (2010) and Chui (2011), as they asked CP or hospital pharmacists to rate their MWL for a typical day, rather than measuring what their MWL was at a particular moment in time. MWL will normally vary significantly throughout the day and as different tasks are undertaken.

Grasha's (2001b; 2002b) study in particular used a diary to measure pharmacists' and pharmacy technicians' MWL in conjunction with a

prevented DE log. Participants were asked to rate their MWL in the early, middle and late parts of their shifts. One finding was that the MWL experienced by pharmacists and pharmacy technicians was significantly different. For example, compared to pharmacy technicians, pharmacists found dispensing more physically demanding, less effortful and less frustrating (Grasha, 2001b). Table 5.1 below reproduces the MWL scores reported by Grasha (2001b). The format on the rating scale of the version of the NASA-TLX scale used by Grasha (2001b) was different to the one used in the current study. Each item of the NASA-TLX was rated from 0 to 100 in Grasha's (2001b) study compared to a scale of 0 to 10 used in this doctoral research.

Table 5.1: Mean MWL scores reported by community pharmacist and pharmacy technicians in Grasha's (2001b; 2002b) MWL diary study

	Pharmacists	Pharmacy Technicians
Overall Tension	58.5	55.3
Mental Tension	69.2	69.8
Physical Demand	45.5	36.4
Temporal Demand	45.3	42.4
Performance Concern	86.1	89.7
Effort	68.7	76.3
Frustration	38.4	62.4

As there are no published figures on the range of MWL that UK CPs experience, a study was carried out to complement and build on the data collected in the experimental study reported in chapter 4. The study measured CP's MWL for a day. This data was collected in order to be able to draw comparisons between the levels of MWL measured in the accuracy checking studies and those which CPs report in their day-to-day community pharmacy practice. This study also forms the first detailed evidence on how UK CPs' MWL varies throughout the day.

5.3. Methods

A diary study was undertaken to measure CP's MWL throughout the day. This method was chosen as CPs had already completed paper and pencil

versions of the NASA-TLX MWL measure in the accuracy checking study. It was also an unobtrusive measure of MWL, compared to other techniques which can be used to measure MWL over longer periods of time e.g. near infrared spectroscopy (Wickens, et al., 2013). A large proportion of the evidence collected to date on either CP or hospital pharmacists' MWL has been through the NASA-TLX or a modified version of this scale and other scales, for example the Subjective Workload Assessment Technique (Luximon & Goonetilleke, 2001).

Diary studies have been used in a variety of research settings, in both quantitative and qualitative research. For example within psychology many structured diaries have been used to measure experiences of pain throughout the day or week (Cruise, Broderick, Porter, Kaell, & Stone, 1996) or the impact that deliberate practice has on the development of expertise in musicians (Ericsson, Krampe, & Tesch-Romer, 1993). Diaries with a qualitative focus, which allow participants to write free text (rather than log events or respond to closed questions) are also widely used. For example, one study used diary entries made during the course of a year by seven (head or neck) cancer patients' to learn about their experiences of recovery, their thoughts and how they adapted to their new appearance following facial surgery (Furness & Garrud, 2010).

The benefit of a diary study for quantitative data collection is that it allows researchers to measure self-reported subjective states, or behaviour in a naturalistic setting (Furness & Garrud, 2010). For measuring MWL a diary study is ideal as participants can report their experiences of MWL in the moment rather than retrospectively (Bolger, Davis, & Rafaeli, 2003). However, there are also common difficulties which researchers may encounter using this method. For example, participants may forget to complete the diary at times or they may lose motivation or interest in completing the diary (depending on the length of the diary study) (Furness & Garrud, 2010).

5.3.1. Ethics

Research ethics approval was granted by the Research Ethics Approval Committee for Health (REACH) at the University of Bath for MWL diary study (in conjunction with the qualitative and experimental studies with CPs) on 24th February 2012.

5.3.2. Participants

Following participation in experiment 1 or 2 CP participants were invited to take part in the MWL diary study (at this time participants were also invited to take part in the qualitative interview study). Thirty five community pharmacists who had taken part in either experiment 1 or 2 expressed an interest in taking part in the MWL diary study. These community pharmacists were sent a diary by post. Twenty six of the diaries posted were returned (74% response rate). Fourteen diaries were also completed by community pharmacists who were taking part in the semi-structured interview resulting in a total of 40 MWL diaries being collected.

5.3.3. Materials

CPs were sent a MWL diary which contained the space for 7 MWL ratings (1 per page). At the beginning of the diary was two pages of demographic information about the CP (sex, years of experience, working hours) and about their pharmacy (e.g. dispensing volume, extra services offered) Participants were asked to complete a minimum of two MWL ratings throughout the day but they were given the space for 7 ratings should they wish to complete them. Participants were also asked to complete a MWL rating at one "busy time" and one "quiet time" in their pharmacy. The "busyness" of the pharmacy was rated at the top of each MWL rating, and the time and the date of the rating was also recorded. See Appendix 3 for a copy of the MWL diary.

5.3.4. Analysis

The MWL diary responses were entered and analysed using a database created in SPSS version 20. Before carrying out the analysis the data set

was screened for any unexpected or impossible inconsistencies in values and for outlying data. Descriptive statistics were produced for participants' characteristics, pharmacy characteristics and their MWL scores. The MWL scores were then compared to the MWL scores obtained in experiments 1 and 2 with a series of independent samples t-tests. Bivariate correlations were also produced to explore whether MWL scores varied according to participant demographics.

5.3.5. Participant Characteristics

The participants who took part in the MWL diary study were not strategically selected. The MWL diaries were collected from CPs who took part in either experiment 1 or 2, and had expressed an interest in completing a diary of their MWL during a day at work and returned this diary to the research team. Table 5.2 below outlines the demographic characteristics of the CPs who returned the MWL diaries. All forty participants completed two ratings, although the majority of participants completed more than two ratings and a total of 186 MWL ratings were completed.

Table 5.2: Characteristics of CPs who participated in the MWL diary study

Characteristics		
Sex	Male	19
	Female	21
Mean Age in years (range)		39.4 (24-61)
Ethnicity	White	30
	Mixed	3
	Asian	4
	Chinese	2
	Black	1
Type of Pharmacy the pharmacist participant was working in the day they completed the mental workload diary	Supermarket	7
	Multiple	16
	Small-Medium Chain	3
	Independent	9
	Locum	4
Pharmacist's working hours	Full-time (N)	29
	Part-time (N)	11
Mean number of years of community pharmacy experience (range)		16.25 (1-40)

5.4. Results

5.4.1. Comparing   MWL   reports   made   in   the experiments and diaries

The 186 MWL ratings collected through the MWL diaries were compared to the 208 MWL ratings obtained during experiments 1 and 2 (from the CP participants only) to see how similar they were. An independent samples t-test was performed for each of the individual items of the NASA-TLX scale and the overall MWL score. The mean scores are reported in Table 5.3 below along with the results of the independent samples t-tests. As can be seen from Table 5.3 overall MWL scores were very similar and did not significantly differ. However, participants' scores on the physical demand and task frustration items in the MWL diaries were significantly higher compared to their scores during the experiment. Participants rated their effort and mental demand significantly lower in the diary compared to during the experiment. Temporal demand and performance scores did not significantly differ.

Table 5.3: Mean MWL scores reported by CPs in experiments 1 and 2 and in the MWL diaries

	Where the MWL ratings were made	Mean	Std. Error	Std. Deviation	t (df)	P	Effect size (*r*)
Mental demand	Diary	6.28	.18	2.50	-6.25	p<.001	.33
	Experiment	7.64	.15	1.66	(315.90)		
Physical demand	Diary	4.23	.19	2.60	7.17	p<.001	.36
	Experiment	2.52	.19	2.05	(351.03)		
Temporal demand	Diary	5.88	.21	2.88	-.71	p>.05	
	Experiment	6.08	.22	2.57	(392)		
Performance concern	Diary	2.23	.14	1.88	.95	p>.05	
	Experiment	2.07	.14	1.51	(392)		
Effort	Diary	6.53	.17	2.32	-2.32	p<.05	.12
	Experiment	7.02	.16	1.77	(343.87)		
Task frustration	Diary	4.51	.23	3.19	5.38	p<.001	.27
	Experiment	2.93	.22	2.57	(355.17)		
Overall MWL	Diary	4.94	.14	1.98	1.3	p>.05	
	Experiment	4.71	.11	1.26	(392)		

5.4.2. Mental workload throughout the day

Participants were asked to rate their MWL a minimum of twice throughout their day of work. Figure 5.1 below charts how MWL levels changed throughout the day for the 40 participants. Of particular interest are the performance concern scores which are highest first thing in the morning despite all the other items from the MWL score being low at this time. Low scores on the performance concern item mean that CPs felt that their performance was good (and not impaired by their MWL or other factors). High performance concern scores suggest that CPs are feeling that their performance was not as high as it could be at that time.

For the CPs in the diary study, mental demand and effort were highest when CPs were working late shifts (around 8pm). A large dip in all MWL items is seen around 7pm. This could be because pharmacists who had been working during the day time were coming to the end of their shift or because the pharmacy had closed to customers and they were using the time to catch up on other tasks.

CPs were also asked to rate how busy their pharmacy was at the time they completed the MWL ratings. The MWL diaries suggest that there are two peaks in the busyness of the pharmacy - 11 o'clock in the morning and five o'clock in the evening. Figure 5.1 above also shows that the MWL items that reflected the highest pressures throughout the day were effort and mental demand.
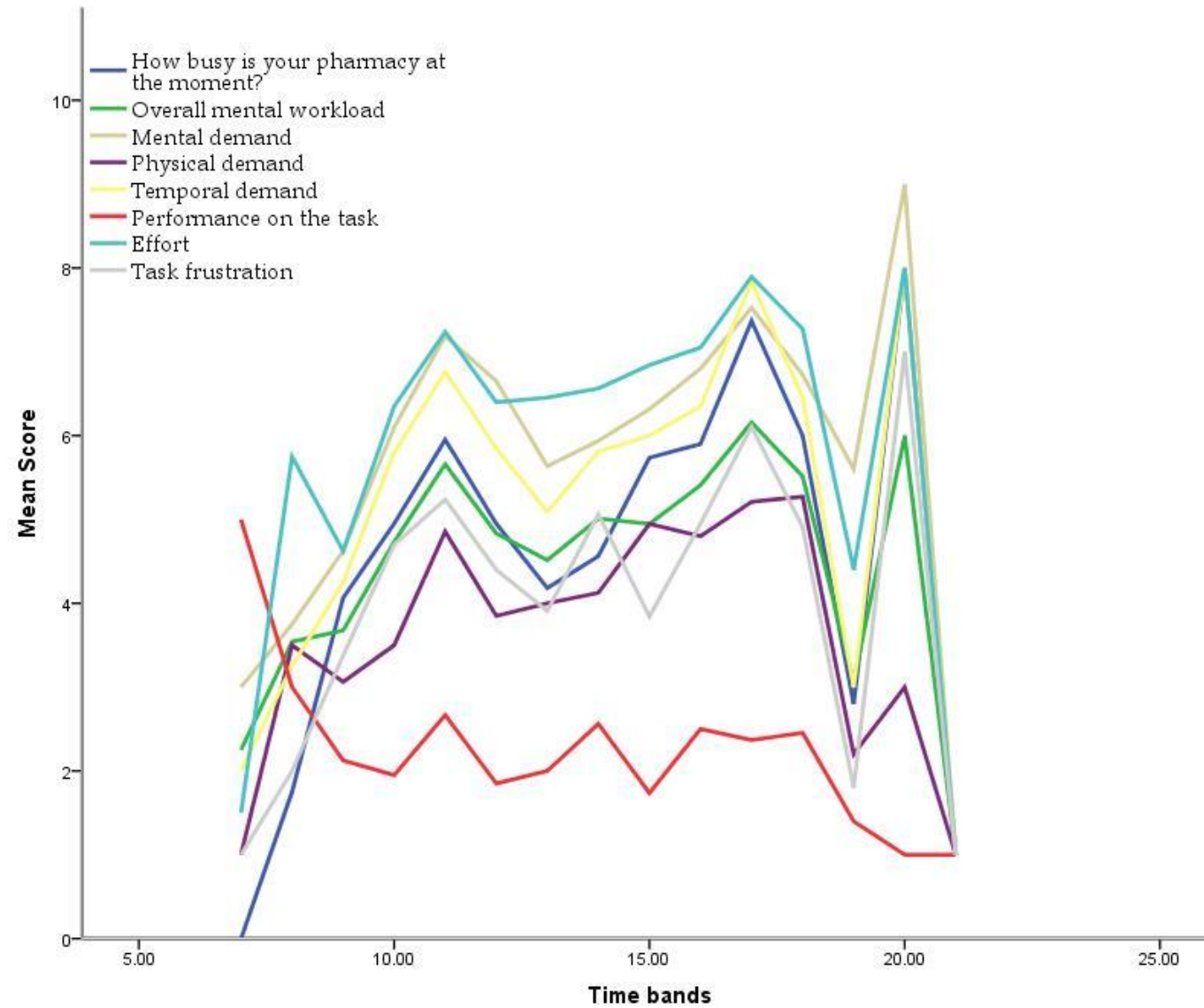
Figure 5.1: Graph of the NASA-TLX MWL items and pharmacy "busyness" plotted against time of day

5.4.3. Pharmacists reflections on the MWL diaries

Fourteen pharmacists who took part in qualitative interviews also completed a MWL diary and they were asked to reflect on the experiences relating to these ratings during the interviews. The main findings from the qualitative interviews are presented in Chapter 6, in this chapter some of the CPs reflections on their MWL diaries are presented below, accompanied by graphs of their MWL diaries. The quotes chosen illustrate how MWL levels relate to the activity in the pharmacy through the day.

Community pharmacist 67 (who is a supermarket pharmacy manager) described how the volume of work to be carried out changed throughout the day in their pharmacy:

> *"...in the morning time it slowly works up if that makes sense, but the pharmacist always because he has got to prepare the methadone in the morning, so we do that in the morning and that takes about an hour an hour and a half sort of do a bit of paperwork until the delivery comes in, 10 – 11. The delivery comes and then it goes absolutely manic and then it sort of calms down again around about 1 o'clock then it goes busy again yeah because your scripts come back. Then depending on how many we get back you are possibly going up until 6, 5, 6 o'clock. So it is pretty continuous and then if I am doing the late night around about 7, 8 o'clock it just dies down again obviously you get one or two customers per hour but it just completely dies down compared to the main bulk of the day."* **Community Pharmacist 67**

Looking at the MWL diary produced by community pharmacist 67 (see Figure 5.2 below) it can be seen that their mental demand, temporal demand (time pressure), and effort scores are all rated at 10. Ten is the maximum score for these items and indicates the highest levels of mental and temporal demand and effort. It can be seen that their mental demand levels peak first at 11 o'clock in the morning which is the time they said the delivery arrives and *"it goes absolutely manic."*
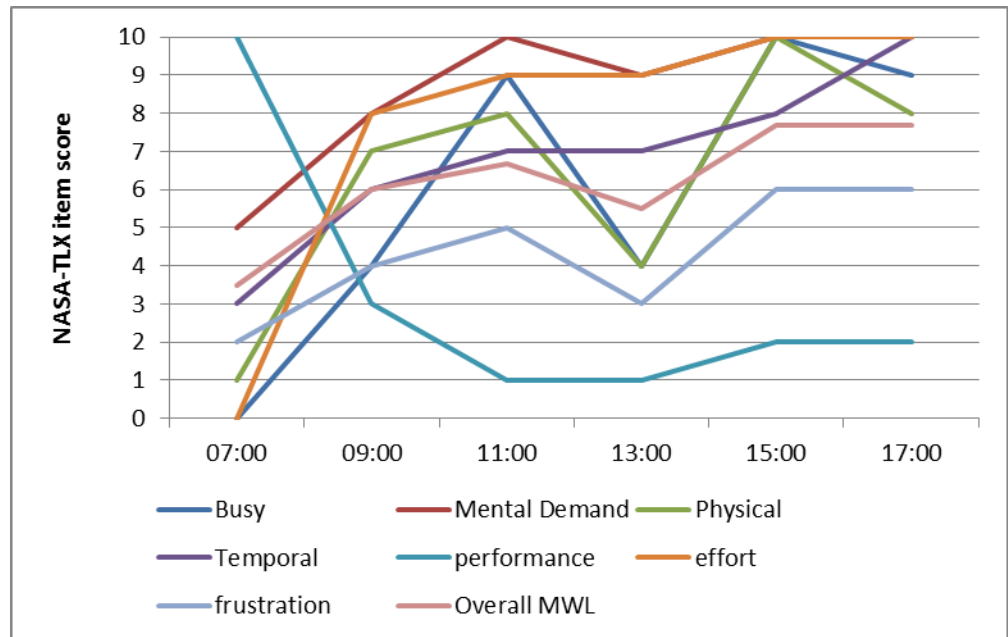
Figure 5.2: Community Pharmacist 67's MWL diary

The MWL diaries produced by the participants who were interviewed showed quite different profiles. For example community pharmacist 12's diary (see Figure 5.3 below) showed a peak at 3 o'clock instead of 5 o'clock in the afternoon, although like community pharmacist 67, community pharmacist 12 felt that the pharmacy got busier from half past ten in the morning. What was particularly interesting about community pharmacist 12's response was that their frustration was rated higher than community pharmacist 41's (see page 195). In the interview community pharmacist 12 (pharmacy manager at an independent pharmacy) was asked why their frustration levels were so high and they said:

> "..always it feels like I have got 3 or 4 things, 3 or 4 different tasks to do at any one time and things, people I need to ring suppliers I need to chase, and I need to sit and discuss things with staff or give them training. And I have got a list of 3 or 4 things that I want to do and then particularly when things get busier at half 10, 11 and the spike around lunchtime, I find that then you're really just over a little bit of a barrel as to what comes in the door. Umm so you have to do the prescriptions there and then, you have to give 100% attention to that customer, you have to make sure that you are listening out to the counter to make sure that your staff are giving the right

advice and information and intervene where necessary. And so you have always got half an ear on what is going on, on the counter and you want to give that the best possible service that you can and, so I find that my list of things that I actually want to do to progress the business, and progress me and my colleagues takes a back seat. But you are still thinking about them all the time. So my level of frustration is that I can't just tick things off my list one by one, I can't do everything that I want to do because you are bound by what comes in the door" **Community pharmacist 12.**
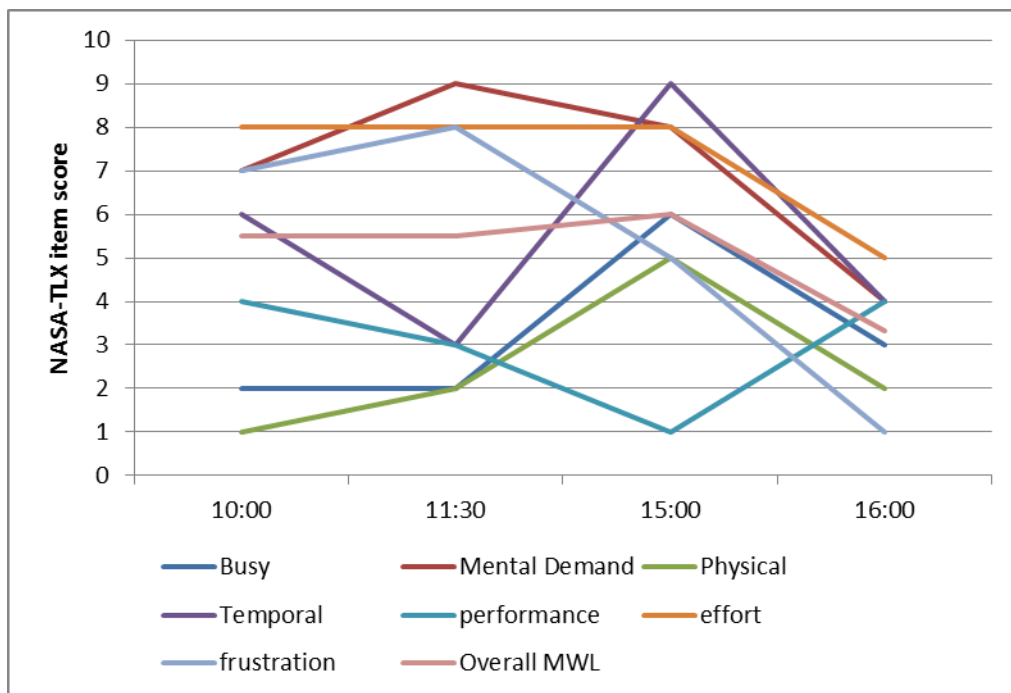
Figure 5.3: Community Pharmacist 12's MWL Diary

Community pharmacist 41 (Pharmacist manager and owner of an independent pharmacy) also rated their frustration very high during the day. When asked about this they revealed that frustrations do not always occur for work reasons:

"…something had just fallen on me and hurt me and so I was really cross that I couldn't do what I wanted to do, and I had to sit with my foot up for a bit to stop my leg swelling. And so I was feeling very tender, and very cross, and frustrated." **Community Pharmacist 41**

Community pharmacist 41 also showed an interesting change in their performance concern scores. This participant's scores were low at the beginning of the day (so little performance concern) but had risen by 11 o'clock (see Figure 5.4 below). When asked why their performance scores had changed throughout the day they said:

> *"That is because more things piled up, so although it didn't feel busy in the shop which is how I rated that one* [refers to busyness question on the diary], *whether we were quiet or not, umm, but in fact the number of things I was having to pile up and do later was getting worse. So it was actually getting more, the work, the anxiety about forgetting something that I was supposed to still be doing, umm increases during the day."*
> ***Community pharmacist 41***

Community pharmacist 41 and 12 both speak about wanting to tick things off their to-do lists. For participant 12 this was reflected in their frustration scores, whereas for community pharmacist 41 this was related to their performance concern. The impact of individual differences on MWL ratings are explored further in the next section.
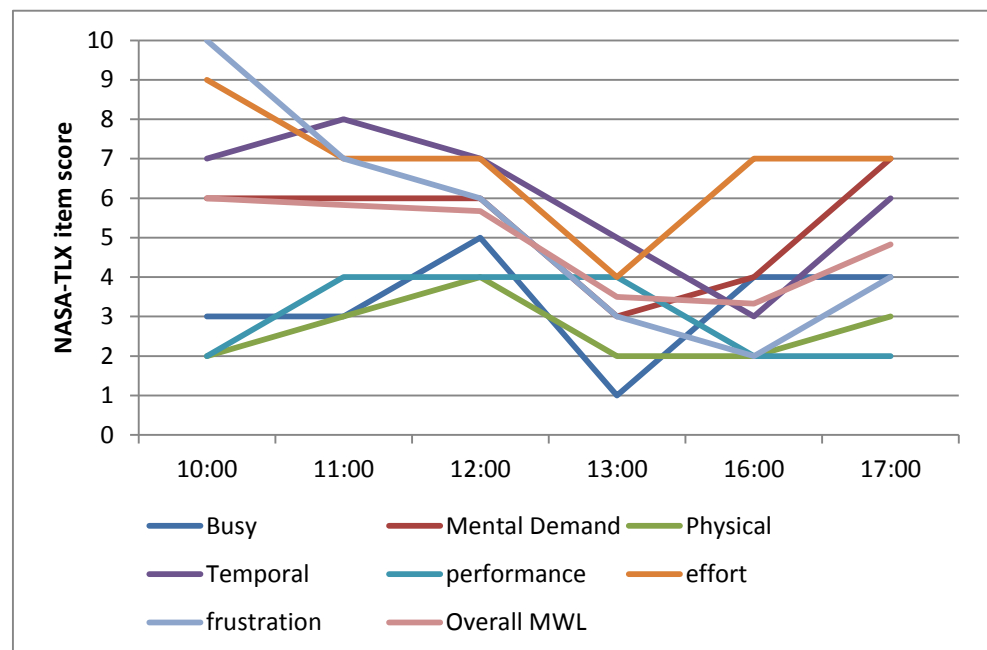
Figure 5.4: Community Pharmacist 41's MWL Diary

5.4.4. Individual differences and MWL ratings

The MWL ratings were compared according to participant demographics (age, sex, years of experience, the type of community pharmacy the participant works for, and whether they work full-time or part-time). An independent samples t-test was carried out to compare the MWL ratings of men and women and no significant differences were found (94 of the 186 ratings were made by men and 92 by women).

Bivariate correlations were produced for participants' age and their MWL ratings. No significant correlations were found between the participants' age, overall MWL, the individual NASA-TLX items and pharmacy busyness indicating that there was no relationship between participants' age and their MWL. Similarly no correlation was found between the years of pharmacy experience participants had and their MWL scores.

Forty eight MWL ratings were received from pharmacists who worked part-time and 138 ratings from pharmacists who worked full-time. Table 5.4 below reports the mean MWL and pharmacy busyness scores made by pharmacists who worked full-time and part-time. Independent samples t-tests showed that pharmacists who worked part-time reported significantly lower levels of physical demand, performance concern and overall MWL. One-way ANOVAs were carried out to identify whether there were any significant differences in MWL ratings according to the type of pharmacy the CPs worked for. No significant differences were found, although this may be due to small numbers of participants in each group.

Table 5.4: MWL and pharmacy busyness ratings made by CPs who work full-time and those who work part-time

Questionnaire Item	Working hours	Mean	Std. Deviation	Std. Error Mean	t (df)	P	Effect size (*r*)
How busy is the pharmacy at the moment?	Full time	5.38	2.73	.23	1.37 (184)	p>.05	
	Part time	4.75	2.75	.40			
Mental Demand	Full time	6.34	2.52	.22	.51 (184)	p>.05	
	Part time	6.13	2.46	.35			
Physical Demand	Full time	4.69	2.64	.23	5.00 (111.40)	p<.001	.42
	Part time	2.90	1.94	.28			
Temporal Demand	Full time	5.94	2.89	.25	.48 (184)	p>.05	
	Part time	5.71	2.87	.41			
Performance	Full time	2.46	1.96	.17	2.83 (184)	p<.01	.20
	Part time	1.58	1.44	.21			
Effort	Full time	6.70	2.25	.19	1.71 (184)	p>.05	
	Part time	6.04	2.48	.36			
Task Frustration	Full time	4.70	3.20	.27	1.35 (184)	p>.05	
	Part time	3.98	3.13	.45			
Overall MWL	Full time	5.14	1.99	.17	2.29 (184)	p<.05	.17
	Part time	4.39	1.86	.27			

5.4.5. Summary of findings from the mental workload diaries

- MWL diary ratings of MWL levels during "real life" pharmacy practice were compared to MWL ratings obtained during experiments 1 and 2. No significant difference was found between overall MWL ratings from the two settings. However, differences were observed for some of the individual items of the NASA-TLX scales:
  - reports of physical demand and frustration were higher during "real life" practice,
  - effort and mental demand were rated significantly lower on the MWL diaries compared to during the experiment,
  - temporal demand and performance item scores did not differ.
- The MLW diary ratings were plotted against time to see how they varied at throughout the day.
  - CPs felt their performance was poorest first thing in the morning

o Mental demand and effort scores were highest around eight o'clock in the evening

o A large dip in all the MWL items was seen around seven o'clock in the evening which is likely a reflection of most CPs preparing to finish their shift for the day (or when the pharmacy closes to patients).

o Pharmacy "busyness" peaks were seen at 11 o'clock in the morning and again at five o'clock in the afternoon.

- The MWL diary ratings were analysed to see if they varied according to CP demographics. CPs who worked part-time reported significantly lower (overall) MWL scores compared to the CPs who worked full-time.

5.5. Discussion

This study was designed to assess the levels of MWL experienced by CPs during a day in their pharmacy so that these experiences could be compared to those reported by CPs in experiments 1 and 2. A number of similarities between the experimental and diary MWL ratings were found, but there were also differences. Three individual MWL diaries accompanied by quotes from the qualitative interviews were used to illustrate the experiences that these MWL ratings related to. This study has provided the first data on the levels of MWL CPs working in the UK experience throughout a shift in their pharmacies.

5.5.1. Comparing MWL reports made in the experiments and diaries

The individual NASA-TLX item scores and overall MWL reported by CPs who took part in experiments 1 and 2 and on the MWL diaries were averaged and compared. Two aspects of MWL were scored significantly higher in the diaries than during experiments 1 and 2. These aspects were physical demand and frustration. It was not surprising that physical demand scores were lower in the experiments than those experienced in real-life as CPs were seated whilst they carried out the accuracy checking studies. This is a limitation of experiments 1 and 2 because CPs in practice

would normally stand for most of the day as the dispensary benches are at standing height. It is likely that this would have contributed to the difference in physical demand scores. There is some suggestion from the qualitative data reported in section 5.4.4 above that frustration levels may relate to CPs' awareness of the work still to be done. During experiments 1 and 2 CPs were able to carry out the accuracy checking task in isolation without concern for other pharmacy work that needed to be carried out. Frustration is explored in greater detail in the next chapter which reports the qualitative interview findings.

Two factors of MWL were rated at similar levels during the experiments and in real life practice. These aspects were temporal demand and performance concern. With regards to the temporal demand item scores it seems that the amount of time given to CPs to carry out the accuracy checking tasks in experiments 1 and 2 was comparable to the amount of time they felt they had to carry out their work in their day to day practice. However, the scores in both the experimental and real-life settings were over 5 and therefore this indicates that CPs are experiencing a significant level of time pressure. Time pressure also peaks at a score of 8 around 5 o'clock in the afternoon suggesting that exceptionally high levels of time pressure are experienced at particular times of the day. Peaks in time pressure appeared, as might be expected, to be related to peaks in pharmacy busyness.

Mental demand and effort reports were significantly lower on the MWL diaries compared to the levels reported during experiments 1 and 2. This may be because CPs are more familiar with the pharmacy environment and the tasks compared to the experiment setting where there will have been a degree of uncertainty over what to expect. CPs may also have invested more effort during the accuracy checking studies if they felt that their performance was being measured.

5.5.2. Mental workload throughout the day

The patterns of MWL observed throughout the day were very interesting (see Figure 5.1). One aspect in particular, performance concern was on average reported by pharmacists to be at the highest level first thing in the morning. At this time, all other aspects of MWL were at their lowest. This may reflect participants needing time to mobilise effort and mental resources first thing in the morning. This suggestion is explored in chapter 6 in the qualitative interviews. Previous research suggests that MWL ratings themselves do not vary with times of the day (Hancock, Vercruyssen, & Rodenburg, 1992). It can therefore be suggested that variations in MWL ratings reflect changes in task demands. The "busyness" ratings support this suggestion as that the volume of work CPs are undertaking varies at different times of the day. The fluctuation of workload that can be seen during the day (see Figure 5.1 above) could be a cause for concern because Grasha (2002b) found that shifts from low to high or high to low volume of work predicted increases in prevented DE reports.

The MWL ratings obtained during this study are fairly similar to those that Grasha (2001b) found in his study with CPs and pharmacy technicians. However, caution is taken in drawing these comparisons as Grasha et al used a different scale format. Two aspects of MWL were rated higher by the CPs in our study compared to Grasha's (2001b) pharmacists. These aspects were temporal demand and frustration. The other aspects of MWL were very similar suggesting that this may be a robust MWL signature for the CPs role.

5.5.3. Individual differences and MWL ratings

No significant difference was found in MWL ratings for age, sex or amount of pharmacy experience CPs had. Similarly no difference was found in MWL ratings according to the type of pharmacy the CPs worked, however this may be due to the small sample size. A significant difference in physical demand, performance concern and overall MWL was found

between CPs who worked full-time and part-time. CPs who worked part-time rated these aspects significantly lower, however it is not clear from the data collected why this may be. It may be that CPs who work part-time undertake slightly different roles in the pharmacy compared to full-time CPs and therefore experience less overall MWL and physical demand. Alternatively their shifts may be shorter and therefore they spend fewer hours working on their feet compared to full-time CPs. These suggestions are speculative and previous research has not found a difference in the MWL ratings of full-time and part-time CPs.

Individual differences may also affect the mental states experienced by CPs when presented with the same stressor. The qualitative interviews highlighted that when CPs felt they were not managing to complete the tasks they had hoped to, one CP reported increased task frustration whereas another reported increased performance concern on the diaries. This finding suggests that caution should be taken when generalising reports on one aspect of MWL to a specific stressor in the pharmacy. However the qualitative diaries provided evidence that the NASA-TLX was sensitive to fluctuations in the pharmacy workload, and other stressors that CPs experience during their working day.

5.6. Summary

The MWL diaries provided an in-depth insight into the ratings made by CPs in the accuracy checking experiments and how this may relate to experiences of MWL in real-life practice. The next chapter explores CP and pharmacy students' experiences of MWL during real-life practice further and how they manage the times when their MWL is too high or too low.

CHAPTER 6: QUALITATIVE STUDY OF MENTAL WORKLOAD
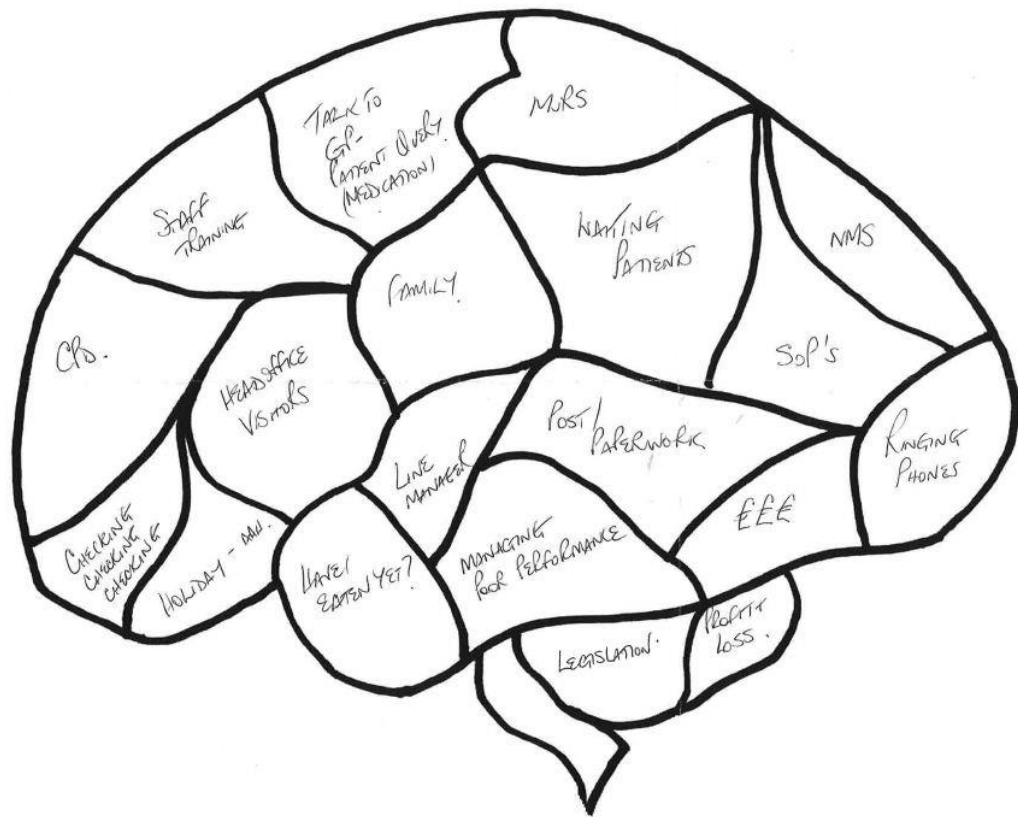
"We were so intent on the dispensing on the treadmill really because that is all it is, you know I could stand there some days and I could be standing there and literally the girls would be giving me a basket and I would be checking it and then I would literally be giving it to a member of staff to bag up to send out and like a production line isn't it."

Community Pharmacist 47

6.1. Overview of the chapter

This chapter presents the findings of study 3, a qualitative study of dispensing errors (DEs) and mental workload (MWL) experienced by community pharmacists (CPs) in their day to day work. Pharmacy students were also interviewed and their experiences of MWL and DEs are compared with the CPs'. This chapter begins with an overview of the qualitative research carried out to date into the workload (WL) of CPs, the causes of DEs, and the MWL experienced by CPs. Next, the methods used for this study; semi-structured interviews and interpretative phenomenological analysis (IPA) are reviewed and compared with other forms of qualitative data collection and analysis. A narrative account of the experiences that CPs and pharmacy students reported during the interviews is provided. The results are discussed in relation to the research outlined at the beginning of this chapter.

6.2. Background

Several qualitative studies have been carried out exploring the WL of pharmacists. Gidman et al (2011; 2007) carried out a large qualitative study with CPs into the causes and consequences of increasing community pharmacy WLs. Issues that CPs reported in relation to WL in this study included feeling overloaded with work, like they worked in a "dispensing factory," they were unable to take breaks and pressure from patients to deliver services quickly. There were several factors which either exacerbated the impact of WL or mitigated some of its negative consequences. For example, well trained support staff were key to managing the WL, other CPs reported reducing their hours in the pharmacy and taking on different roles allowing variation and a break from the dispensary in their working week. Many CPs in Gidman's (2011) study reported lack of support from their organisation or managers and concerns that WL levels were increasing multi-tasking and creating opportunities for DEs to occur.

Gidman, Day, Hassell and Payne (2009) carried out a qualitative study to identify whether pharmacy offered family-friendly working opportunities for women. Many women reported that after starting their families they

found that pharmacy was not as flexible or as family-friendly as they thought it might be. The role of the pharmacy manager was often seen as incompatible with family life, due to the need to be available to go into work at short notice, if for example a locum did not arrive for a shift. Working hours whilst flexible often meant that women and their partners would be looking after the children individually whilst their partner was at work and therefore often did not spend time together as whole family (Gidman, et al., 2009). Being unable to balance working and family life can be an issue in safety critical environments. This is because concerns over family life may create mental tension which in turn may impact on mental information processing systems which are being used by a CP to carry out safety critical tasks (Grasha, 2001b; Grasha & O'Neill, 1996; Grasha & Schell, 2001).

Another qualitative study by Eden, Schafheutle and Hassell (2009) linked the increase in pharmacists' (both hospital and community based) workloads to job dissatisfaction and intentions to leave the profession in recently qualified pharmacists. Participants working in a community pharmacy setting reported feeling undervalued as the dispensing WL was too high for them to put their specialist skills to use. Other CPs reported dissatisfaction with the target culture and the pressure to carry out revenue generating medicine use reviews (MURs).

Phipps, Noyce, Parker and Ashcroft (2009) carried out a qualitative study into the sociotechnical context and pharmacy safety. In this study pharmacists referred to the influence of professional norms (how colleagues and peers are perceived to deal with errors), blame culture, legal and regulatory requirements, protocols and dispensary layout and organisation on safety. Like the participants in the studies by Gidman et al (2011; 2007), pharmacists experienced pressure from patients to deliver services quickly. One pharmacy owner interviewed in Phipps et al's (2009) study commented that the value of automated dispensing would be allowing them to stop worrying about a DE being made during the

dispensing of the medicine so that they could focus on the medicine itself and whether it was appropriate for that patient.

A qualitative study using the critical incident technique was carried out with hospital pharmacists in the UK (James, Barlow, Hiom, & Whittlesea, 2008). In this study specific DEs were examined and participants completed open-ended questions about why it happened. High WL and insufficient staffing levels were implicated in many of the DEs. Other issues that participants in this study highlighted that haven't been reported elsewhere, was that for two DEs the participants reported that they had been very hungry at the time they made the error. Physical states can act as internal distractions. Environmental stressors, like distractions and interruptions were also commonly cited as contributing to DEs in this study, as well as pressure from ward staff and waiting patients for medicines to be dispensed quickly. Lack of skill and knowledge was cited by dispensing technicians as contributing to DEs (e.g. not knowing that a medicine came in two different forms).

The qualitative research carried out with CPs working in the UK highlight many issues that Grasha et al (Grasha, 2001b; Grasha & O'Neill, 1996; Grasha & Schell, 2001) included in the cognitive systems model (CSM) outlined in Chapter 2. For example the impact of perceived pressures to deliver services quickly, can become a source of tension for the CP and impact on the functioning of their cognitive processes. The roles of professional, organisational and extra-organisational issues were also discussed by participants in these studies. However, since most of these studies were carried out significant changes have occurred in the regulation of CPs. Pharmacists, pharmacy technicians and pharmacy premises are now regulated by the General Pharmaceutical Council (a role the Royal Pharmaceutical Society of Great Britain was responsible for up to September 2010). Economic pressures in the UK have also increased, and changes to the structure of the NHS have led to changes in the way

pharmacy services are commissioned and possibly the pressures that CPs are experiencing (News Team, 2013).

In relation to pharmacy WL and safety the qualitative studies outlined above have not explored the concept of MWL with CPs, or the perceptions of pharmacy students who will shortly be undertaking their pre-registration year. This final aspect of this doctoral research aimed to identify whether CPs related to the concept of MWL, what aspects of MWL were particularly relevant to CPs practice, if CPs regularly experience suboptimal MWL and whether they have developed coping strategies to manage suboptimal MWL. Throughout this research the impact of expertise development on MWL and pharmacy safety has been explored. This issue will also be examined in these interviews through comparing the experiences of pharmacy students and CPs.

6.3. Methods

There are many approaches to undertaking qualitative research, and many methods through which qualitative data can be collected, some of which were discussed in chapter 3. For this study Interpretative Phenomenological Analysis (IPA) was the chosen approach and semi-structured interviews were used to collect the data. The rationales for selecting this approach and data collection method are now discussed.

6.3.1. Interpretative Phenomenological Analysis

Interpretative phenomenological analysis (IPA) is a relatively new qualitative research method as it was first introduced by Jonathan Smith in 1996 (Smith, 1996). In his 1996 paper Smith argued that psychology required an approach which could capture the experiential and qualitative aspects of human behaviour. Smith felt this was needed because the qualitative research methods that psychologists were using at the time were imported from other disciplines (Smith, Flowers, & Larkin, 2009). Linking his aims to those envisaged by William James, Smith states that psychology should be both experimental and experiential (Smith, et al., 2009). Smith's aims for IPA fit neatly with the aim of this doctoral thesis

which was to explore experimentally the MWL of a routine pharmacy task, but also in this final results chapter to explore CP and pharmacy student's experiences of MWL.

IPA draws on three epistemological view points, phenomenology, hermeneutics and idiography. IPA aims to understand the sense people make of their lived (Smith, et al., 2009) or inner experiences (Pistrang & Barker, 2012). Smith and Shinebourne (2012) qualify the distinction between experience and "an experience," stating that something becomes "an experience" when it is important to a person. This aspect of IPA draws on the phenomenological tradition founded by Husserl which is concerned with what the experience of being human is like (Smith, et al., 2009). IPA also draws on the ideas of phenomenologists who came after Husserl, for example Heidegger (1962) who was concerned with the context within which an experience occurred and is made sense in, Merleau-Ponty (1962) who highlighted the role the body plays in enabling experience and Sartre (1943) who was interested in people's interactions with others (Smith & Shinebourne, 2012).

The second theoretical underpinning of IPA is hermeneutics, which is the theory of interpretation. Hermeneutic enquiry was originally applied to historical texts. Heidegger (1962) believed that it was not possible to undertake phenomenological enquiry without a level of interpretation. Heidegger noted that a reader of a text or of an interview transcript has prior experiences, preconceptions and assumptions which will be present when they read this text, and also importantly, enable that person to read the text in the first place (Smith, et al., 2009). A double hermeneutic has been described in IPA as this approach represents the researchers interpretation of an individual's interpretation (or sense making) of an experience (Smith & Shinebourne, 2012).

Finally, IPA is an idiographic approach meaning that it emphasises the experiences of an individual, and what that experience means to that person. For this reason IPA typically uses a small sample of participants

through which detailed analyses can be undertaken (Smith & Shinebourne, 2012).

The three theoretical underpinnings of IPA fit well with the aims of this PhD. A phenomenological approach to this topic is useful because MWL relates to people's inner experience of, or reaction to their working environments, the work itself and many other factors. Hermeneutics allows the researcher to acknowledge their preconceptions and assumptions about the topic that affect their interpretations but also to recognise that an experience is interpreted and recalled by an individual within a context which will also affect its meaning. This is a useful stance when carrying out a qualitative study into a cognitive phenomenon because it fits with contemporary theories of human memory and thought processes. Finally this piece of qualitative research is necessarily idiographic as MWL is an individual experience which relates to the interaction between the characteristics of the individual, the task at hand and the environment in which this task is undertaken (Hockey, 2002).

Having described IPA in detail and how it fits with the aims of the research and the topic under study, the following paragraphs compare IPA with other forms of qualitative data analysis.

IPA can be classed as a thematic approach to qualitative data analysis. Methods grouped under the thematic approach aim to identify and describe the key ideas or themes that occur in the data (Pistrang & Barker, 2012). Other forms of thematic analysis include, thematic analysis (Braun & Clarke, 2012), content analysis, framework analysis (Ritchie & Spencer, 1994) and grounded theory (Glaser & Strauss, 1967). Other approaches to analysis include narrative approaches which focus on how events and experiences happen over time (e.g. life-history research) and language-based approaches (e.g. conversation and discourse analysis) which look at the structural and social aspects of how language is used by people (Pistrang & Barker, 2012).

A thematic approach was chosen for this research so that factors (themes) that affect CPs and pharmacy students' experiences of MWL and the occurrence of DEs could be identified. IPA was chosen over the other methods for several reasons. First the level of detail required from the analysis was considered, for example, content analysis is a quantitative method for analysing qualitative data through counting the number of instances a word or a theme occurs. This method does not provide sufficient depth or detail of analysis for the purposes of this study. Grounded theory by contrast requires detailed analysis of qualitative data in order to develop a theory which is grounded in the participants' narratives (Pistrang & Barker, 2012). The aim of this qualitative study is not to provide a theory of CPs MWL but to identify whether the experiences reported by CPs and pharmacy students map onto theories of cognition and human information processing that already exist. Framework and thematic analysis would have provided suitable alternatives for analysing the qualitative data in this study. However, they are not used to explore the individual experience, and as discussed above MWL is an individual experience and so this quality should be captured in the analysis. For these reasons IPA was chosen for this study.

6.3.2. Semi structured interviews

Face-to-face semi-structured interviews are the main method of qualitative data collection used in IPA research (Smith, et al., 2009). An interview topic-guide is written for a semi-structured interview, allowing for a set of open-ended questions to be planned in advance (DiCicco-Bloom & Crabtree, 2006). The aim when conducting a semi-structured interview and IPA data collection is that the interviewee is a participant in meaning making, instead of a source from which information is to be retrieved (DiCicco-Bloom & Crabtree, 2006, Smith, et al., 2009). Semi-structured interviews allow flexibility in the data collection process as they allow similar questions to be asked of all participants, but also for the interviewer to probe for more detail or ask questions off the interview topic guide if unexpected themes emerge during the interview process

(Smith & Eatough, 2006). Another popular method of qualitative data collection is the focus group, but this method is rarely used in IPA research because it does not allow the researcher to collect data on individuals' experiences as readily as a one-to-one interview. A topic guide was developed (see Appendix 2) for interviews with pharmacy students and community pharmacists to explore participants' experiences of MWL and also DE incidents they had experienced.

6.3.3. Ethics

Research ethics approval was granted by the Research Ethics Approval Committee for Health (REACH) at the University of Bath for the qualitative study with pharmacy students on 16th September 2011 and with community pharmacists on 24th February 2012.

6.3.4. Participants

Recruitment

The semi-structured interviews were carried out mid-way through the study period for experiments 1 and 2 for both pharmacy student and CP participants. The aim was to interview participants who had taken part in experiment 1 and 2 so that participants could reflect on their experiences during either experiment 1 and 2 and relate them back to their experiences in community pharmacy practice. Towards the end of experiment 1 and towards the end of experiment 2 for the pharmacy student and CP studies participants who had already taken part were e-mailed a letter of invitation to take part in the qualitative follow-up study. They had been informed that they would be contacted at a later date about the follow-up study when they participated in experiments 1 or 2. Participants were also informed at this time that they were not obliged to take part in the interview because they had taken part in one of the experiments. Participants expressed an interest in taking part through return e-mail.

A larger than anticipated number of pharmacy students (n=30) and community pharmacists (n=40) expressed an interest in taking part in the semi-structured interviews. For the CP participants it was decided at the

time to extend the planned sample for the MWL diary study, but not the CP interviews as it was not possible to interview so many CPs. Pharmacy students and CPs that were interviewed were purposively selected from the pool of participants who had expressed an interest to take part. Fifteen pharmacy students were selected based on their amount of pharmacy experience and to reflect a range of ages and to ensure an even representation of both sexes. Fifteen CPs were selected for interview based on their pharmacy experience, the type of pharmacy they worked for, their age and to ensure an even representation of both sexes. One CP withdrew their expression of interest before the interview took place and the decision was taken not to replace this participant as fourteen CPs was a sufficiently large sample for this study.

Twenty-nine participants are too many for an IPA study. With such a large sample size one cannot maintain a commitment to the individual experience. Over-recruitment occurred because the CP and pharmacy student studies were designed as separate (but complementary) studies at the beginning of the doctoral research due to the uncertainty of funding for the CP study (funding for the CP study was awarded half-way through this doctoral programme). In order to compare the experiences of CPs and pharmacy students and provide a full account of the impact of pharmacy expertise on the experience of MWL and DEs using IPA, only half of the transcripts from the interviews were jointly analysed. The full data sets have been analysed separately in preparation for stand-alone papers on the experiences of MWL reported by pharmacy students and CPs.

The transcripts of eight pharmacy students and eight CPs who were interviewed about their experiences of MWL and community pharmacy practice were analysed following the process outlined by Smith et al (Smith, et al., 2009) this process is outlined in the analysis section below). The characteristics of the eight pharmacy students and 8 CPs whose interviews were analysed using IPA are reported in Tables 6.1 and 6.2 below.

Table 6.1: Characteristics of community pharmacist interview participants

CP participant number	Job title	Type of Pharmacy	Age	Sex	Years of Community pharmacy Experience	Full-time or Part-time
3	Pharmacy Manager	Supermarket Chain	30	Female	6	Full-Time
12	Co-owner	Independent Multiple	30	Male	8	Full-Time
29	Pharmacy Manager	Pharmacy	28	Male	4	Full-Time
41	Owner	Independent Small/ Medium	55	Female	33	Full-Time
47	Pharmacy Manager	Chain	43	Female	15	Full-Time
49	Locum	Independent and small-chain pharmacies	67	Female	42	Part-time
60	Pharmacy Manager	Multiple pharmacy	24	Male	1	Full-Time
67	Pharmacy Manager	Supermarket Chain	26	Male	3	Full-time

Table 6.2: Characteristics of pharmacy student interview participants

Pharmacy student participant number	Age	Sex	Community experience (weeks)	Hospital experience (weeks)	Total amount of pharmacy experience (weeks)
4	22	Female	112	6	118
8	22	Male	131	1.5	132.5
10	21	Male	15	1	16
19	21	Male	3	5	8
64	21	Female	6	9	15
66	21	Female	10	1	11
69	21	Female	38	3	41
73	23	Female	188	0	188

Participant Payment

Pharmacy students were paid £15 for their participation in the interviews (this was in addition to the payment made for participation in experiment 1 or 2). So that CP participants did not have to take time off work to participate in the interview, their employers were reimbursed for the time

their pharmacists spent participating in the study or costs for locum cover. However, some participants preferred to take part on a day off and they were therefore reimbursed the equivalent of a locum fee for their participation. This meant that participating CPs received their normal salary or wage for participating in the study. Participants travel expenses to and from the University of Bath (or agreed meeting place) were reimbursed.

6.3.5. Procedure

The semi-structured interviews lasted between 45 minutes to one hour and 30 minutes. Before the interview started participants were fully informed of the aims of the interview and that it would be recorded on a digital Dictaphone. Participants were also informed how their narratives would be anonymised prior to the analysis and reporting of data. Participants were given the opportunity to ask questions and if they were still happy to take part, give their written consent. At the end of the interview participants were de-briefed and thanked for their participation.

6.3.6. Analysis

All interviews were digitally recorded and these recordings were then professionally transcribed. HF checked the tapes by listening to each one whilst simultaneously reading the transcriptions. At that time, minor alterations were made such as adding or correcting words that the transcriber had not heard clearly and correcting any typing errors. Contextual information noted during each interview such as laughter and pauses were also added to the transcriptions.

IPA sets out clear guidelines for the analysis of interview transcripts. Following the verification of transcripts the transcripts are re-read one or two times before the analysis begins. This process allows the researcher to immerse themselves in the original data. The next stage involves initial noting where the researcher makes descriptive comments (e.g. about key events, experiences), conceptual comments (e.g. why did the participant say that, mention this issue, what is this significance of this event?), and

notes the participants use of language (e.g. metaphors the participant uses and the fluency or hesitancy of speech). Once these detailed initial notes are made the next stage is to identify emergent themes, using a word, or phrase to summarise the notes on a particular section (Smith, et al., 2009). This process is followed for each participant's transcript. During the analysis emergent themes were identified which were gradually refined and renamed, as patterns in the words and phrases began to emerge, which were common to participants narratives.

The initial noting and emergent theme stages of the analysis were carried out on the transcripts which had been imported into QSR NVivo Version 10. NVivo is specifically designed for the analysis of one or more sources of qualitative data. The benefit of using this software is that sections of the transcripts relating to emergent themes can instantly be compiled across a sample of participants. Development of superordinate themes was carried out by coming out of the database and grouping emergent themes into clusters to form superordinate themes which were then named to capture the essence of what these clusters of themes represented as a whole.

To check the reliability of the coding of the transcriptions, Dr Jane Sutton (JS), supervisor of this doctoral research also carried out the coding and emergent theme process on one transcription. HF and JS then compared codes to ensure agreement of both meaning and context. Once the coding had been completed by HF, JS confirmed the first two superordinate themes by checking the participants' narratives.

Definitions and descriptions of the superordinate themes, and themes can be found in Appendix 4.

6.4. Results

Eleven superordinate themes emerged from the analysis. A narrative account of participants' experiences of working in a community pharmacy and of MWL and pharmacy pressures is presented below. Extracts from participants narratives are shown in italics in the text. Where the

interviewer (HF) has asked questions these are in bold, italicised text. These are quoted verbatim to retain the authenticity of the participants' narratives. The aim of the results section is to present experiences that were common to most or all participants, but also emphasise the importance of these experiences to the individuals quoted. Throughout the analysis, it became clear that different stressors in the pharmacy were important to some CPs, but not all. There was also a difference in the stressors that affect pharmacy students and CPs and this is explored as the account of the data progresses.

6.4.1. The development of expertise

A key focus of this doctoral research was to explore the role of expertise in the levels of MWL that pharmacists and pharmacy students experience and in the occurrence of DEs. Throughout the interviews both pharmacy students and CPs reflected on the development of their expertise. All the students interviewed felt that they had yet to encounter a large range of medicines. This lack of knowledge about different medicines was identified by many to be the cause of the DEs they made on placements or during dispensing classes, as this example from pharmacy student 66 demonstrates:

> "… sometimes because I just don't know the difference, you just don't realise that that particular drug has the two different forms, so you thought it's just the one." Pharmacy Student 66

For many pharmacy students this acquisition of knowledge was a natural part of learning to be a pharmacist and did not cause them much concern. However, pharmacy student 64 explained how encountering a new medicine can "*throw a spanner in the works*" for them and disrupt their thought processes leading them to miss the basic steps they had already learnt.

Other pharmacy students said that working on the counter tested the limits of their knowledge to the greatest extent. Unexpectedly, the

following quote is from a pharmacy student who had gained significantly more experience in community pharmacy practice than all of the other pharmacy students interviewed. They had worked full-time as a dispensing assistant before they decided to study pharmacy but still felt a lack of confidence about working on the counter:

"Yeah, it's not nice. Over-the-counter scares me more than the dispensing because it's just such a minefield you know. I find that over-the-counter is a lot scarier because, like, everyone wants to know which one is the best thing. So you've got like a generic brand of something and another brand – well, why are you selling both of them, what's the difference? And it could be something as small as like a tiny, little ingredient, and the main ingredient's the same. Well, why are you selling both? So they'll come in and they'll ask for something and then they'll ask for something else and then they want to know where something else is, but it could be all the way down the other end of the store and they bring it over with their big trolleys. Basically they can ask you anything and that can sometimes throw me!" Pharmacy student 73

CPs and pharmacy students both talked about the increased automaticity that came as their knowledge about medicines and pharmacy increased for example community pharmacist 47 said:

"There are things that I automatically do that I don't think about now because that knowledge is there" Community Pharmacist 47

However, this pharmacist, who had been working as a CP for almost 20 years, also felt that being newly qualified conferred some other advantages:

"Pharmacists that are newly qualified are much more up to date with a lot of other things, and it takes me a lot longer to get up to speed with things." Community Pharmacist 47

When comparing the pharmacy student narratives with those of the CP participants in this study, it became clear that the main benefit of expertise

for CPs was not knowledge about medicines, or increased automaticity it was about "knowing one's limits." In the following quote one CP talked about this in the context of experience and confidence.

> *"It is hard though especially when you are brand new as a pharmacist to say 'I have to draw a line here'. I guess as you become more so called "experienced" you become more confident in your ability."* **Later this participant says: "***I have done it myself as in, like at the beginning when you first sort of qualify you know you want to do the best of your ability. But you know you could stay on an hour longer, for instance, without being paid for it, for instance, but at the time you think 'I will get a lot done' but after reflecting back on it you never really did that much."* Community pharmacist 67

Knowing one's limits was not just about the hours a pharmacist put in, but also knowing when to step away from safety critical tasks because of stressful events in the pharmacy.

> *"It is also I think about knowing your limits, certainly I can think of cases where patients have got angry with you and I have just said 'right I am just leaving the pharmacy for 15 minutes I don't care, this is a safety thing' or I am so exhausted I am not going to check anymore PCS[14] today. I will do it tomorrow or I will let the locum who is in tomorrow, I will do the walk-ins"* Community pharmacist 3

Community pharmacists 3 and 67, are both managers of supermarket pharmacies, belonging to national chains. Their quotes illustrate that the workload of CPs and the pressures they face (e.g. angry patients) can often go beyond the limits that CPs feel enable them to carry out work safely or effectively. The next superordinate theme explores these pressures in the context of how the role of CP has changed.

---

[14] Prescription Collection Service

6.4.2. The role of the community pharmacist

During the interviews the role of the CP was discussed with participants. These discussions captured some previously reported themes, for example how much the profession had changed in recent years and how members of the public viewed community pharmacy.

Community pharmacist 3, a pharmacy manager of a supermarket pharmacy, felt that things had changed particularly in terms of the expanding role of the CP:

> *"Things have changed phenomenally in the pharmacy over the last 10 years, and we are doing a lot more than we have ever done before. Certainly when I qualified the thought of actually injecting anyone in the pharmacy was completely alien, and now it is something we do sort of year in year out."* Community pharmacist 3

All the CPs in this study welcomed the new services that came with the contractual frameworks. Community pharmacist 47 described a particular day when they had enough staff to be able to delegate all dispensing responsibilities, which gave them time to do some MURs.

> *"To be honest that is really satisfying when you do that and…that reminds you of pharmacy, that reminds you about the real pharmacy and the real issues and just talking to people, because that is the thing that I really, really missed when I was in hospital pharmacy - was the patient contact."* Community pharmacist 47

All CPs reported gaining increased job satisfaction from being able to carry out these advanced services. However, the above pharmacist (community pharmacist 47) also felt that community pharmacy and the role of the CP had, over the years, become less integrated with the healthcare structure and local communities.

> *"I think when I went to be a pharmacist, I did, um, I used to do a Saturday job in XXX* [name of pharmacy chain] *and that was a long time ago now,*

20 years ago. And even then there was some respect there for the pharmacy and the pharmacist and they were part of the community and part of the healthcare structure and I loved it. That was what I wanted and that has gone I think somewhere along the line, and I don't know how that's dissipated really" Community pharmacist 47

For this same pharmacist manager the lack of integration led to a resigned frustration with their role which was expressed throughout their narrative as the continuation of the above quotation shows.

"There is such a sense of frustration when you can't help them [patients] *and sometimes you can't help them just because of the way the system is. There is nothing you can do about that, and it has taken me a long time to learn there is not, there is nothing you can do about that, that is the way the NHS has been set up, it has been set up like that for so long and other people have got control over that."* Community pharmacist 47

The theme spoken of by pharmacist 47 of "others" having control over how their pharmacy is integrated with the local community and other healthcare services was repeated by another CP. This participant who worked for a large pharmacy chain also talked about having no control over their role or the services their pharmacy offered but in a slightly different context. This time it appeared that the chain pharmacy itself imposed restrictions on how the pharmacist could do their job but that they learned to go along with this.

"Working for a company with a chain pharmacy I think always when you get something to do you learn how to not say 'Oh no not again' you just do it." Community pharmacist 29

The previous quotation came from a pharmacy manager in a national pharmacy chain. This participant reported a large amount of frustration over the lack of control they had in how their pharmacy was organised and what services they could offer. This had consequences for both the volume of work their pharmacy was undertaking but also the MWL that

this CP experienced in their practice. This CP (community pharmacist 29) also said "*if it gets a bit too much we give feedback and say sometimes I find myself* [not giving feedback] *you don't want to be the person that makes feedback too much.*" Not wanting to get a reputation for giving too much feedback on new services meant that this CP and their team often put up with significant increases in WL.

Many of the CPs who took part in this study were pharmacy managers and some participants had taken on the pharmacy manager role straight after completing their pre-registration year. Community pharmacist 60 (a pharmacy manager for a large chain pharmacy) talks about the strains of taking on such a demanding role so early in their career.

> "*I had to do that and do the management stuff and be a pharmacist and deal with the walk in patients and so it was a lot of and make sure all the targets were hit.*" [this pharmacist later said] "*I have recently been looking for just a pharmacist job actually not long ago because the store management stuff I am not getting done properly and it is taking a back seat to pharmacy. I think I have gone too far with going into the store management thing and ok I have got a bit of store manager experience but it is so, it is just difficult it is doing two important jobs with one person and it is not having the experience really in either of them, so it is too much really.*" Community pharmacist 60

In the second part of the above quote this CP talks of how the strain of working as a pharmacy manager had led them to seek a different job without the management role. This was because they felt that both parts of their role were suffering.

Community pharmacist 3, echoes community pharmacist 60 when they reflect on the difference between being a pharmacist and a pharmacist manager.

> "*Yes definitely and I'd feel definitely, you know, being quite newly qualified at the time when I started I would come in and look at these locums who were sitting there reading a book in my pharmacy* [laughs] *eating their lunch and*

they had got everything done. I thought gosh, I must be an awful pharmacist because I can't clear the bench by 4 o'clock in the afternoon. 'How can they?' And then you know, two weeks later one of my girls said to me, 'well yeah but they are not doing this, and they are not doing that, and they are not replying to emails and ringing all these people and doing training' and I was like 'Ahhh yes, I'm not going mad!'" Community pharmacist 3

These quotes show the importance of considering the impact of combining pharmacy management with the pharmacist role on MWL and pharmacy safety, as both community pharmacists 3 and 60 were the sole pharmacists in their pharmacy.

In exploring the role of the CP with participants a number of tensions and stressors have been highlighted. The impact of these tensions and stressors are explored in two superordinate themes presented later on in the section about MWL and the pressures that CPs and pharmacy students experience. The next section explores the impact of the CP on the patient experience. This encompasses the pressures that CPs and pharmacy students experience when trying to meet the expectations of patients, and the frequent conflicts between best practice and commercial interests.

6.4.3. The patient experience

Throughout their narratives CPs and pharmacy students reported experiencing pressure and aspects of MWL as a consequence of working to meet patient expectations. Stress and anxiety over the patient experience in the pharmacy was reported by all pharmacy students and CPs. Community pharmacist 12 spoke about how they managed their own "*constant anxiety*" in relation to patient waiting times.

> *"There is that constant feeling of, you know, anxiety that they are getting frustrated that they are having to wait. So wherever I have worked I have always tried to make sure that the staff are realistic with prescription waiting times to give you that, give you that sort of breathing space"* Community pharmacist 12

The use of the term "breathing space" was also used by community pharmacist 12 to explain the importance of not having to break off from what they were currently doing (as they may be half way through another patients' prescription) and so that they did not have to rush what they were doing.

Stress in relation to patient expectations was also reported by pharmacy students who had had experience of working in community pharmacies. Pharmacy student 64 who is quoted below also worked as a waitress during their university holidays, and they compare their experience of keeping dining customers happy, with patients in the pharmacy.

> "*And for me to manage my time in the correct way to keep everyone happy, I think is probably the most stressful thing that I sort of experience* [as a waitress]. *Which, again, is something that is quite parallel in a pharmacy, be it community or hospital when you have different patients coming up and you're very aware of the fact that it's not your time it's their time as well. And managing that and keeping people happy and satisfied for me is quite a stressful thing. When it's going well it's great, but when it's not it's just awful.*" Pharmacy student 64

These quotes indicate that the imperative to manage the pressures of patient expectations is something that is experienced before pharmacists are fully qualified. Sometimes the pharmacist is unable to meet the patients' expectations due to a prescription being incorrect and this leads to an unsatisfied customer and a conflict between professional responsibilities and commercial interests. Community pharmacist 3 spoke about best practice and customer service but how in their pharmacy, time constraints may ultimately be the deciding variable.

> "*Oh yes absolutely, you know and you do get your irate patients, and doctors receptionists are absolutely notorious to try and get past, to try and speak to the GP. But what do you do in that situation when you think that something says something or you think that the dose probably is alright according to the literature, but it might be a little bit under or over? Mm do you say 'oh*

actually I am not going to give this to you until I have spoken to the GP and confirmed it,' knowing that that is potentially going to take 24 hours. Or do you just go with it, not just go with it, but say 'OK well it is just about within the realms?' I think you have got to sort of weigh that up against time constraints, not how angry your patient is because I would always, you know, say 'OK well if you are getting angry with me here is your prescription back, I am trying to act in your best interest but if you don't want me to that is absolutely fine, you can try somewhere else.'" Community pharmacist 3

This quote highlights that due to time pressure this CP may not always question a prescription if it is just about within the realms of legal or safe prescribing. Here different pressures are also considered in relation to each other and in this instance time pressure is a greater influence on this CP's behaviour than pressure from a patient. Time pressure is also discussed in greater detail in section 6.4.6 below.

The balancing of professional, commercial and patient interests becomes even more complex in an independent community pharmacy setting. For example, as community pharmacist 41 explains, the Drug Tariff prices can often leave the pharmacies facing shortfalls in their reimbursement for medicines.

"In September I had something that I had to pay £80 for and I was going to get £12 back and you just think this is just a crazy system because it is a fixed price and yet it is not available from where the tariff thinks it is and because it is at the end of the month, you can't get the Department of Health to change their minds so you have had it."

HF: *"And so you just hope that patient doesn't come back with another prescription?"*

"[laughs] Ever! But you know they will because they need it again but no it is, it's very difficult emotionally and I think, I don't know how other companies manage but I guess when you are vertically integrated you have

more cushioning. I think my accountant might say I am totally healthcare professional and I don't think about my business at all umm. But I think with the advent of changes that have happened in the last few years and the one that has just happened in October [2012 Drug Tariff changes] *it has made you very, very, very much more focussed."* Community pharmacist 41

Community pharmacist 41 described the impact of these decisions on them as emotionally very difficult, in part because this is an issue that not all pharmacies may have to contend with. Some national pharmacy chains are able to mitigate the impact of the Drug Tariff shortfalls as their businesses are vertically integrated in that they also manufacture and wholesale medicines, as well as owning community pharmacies.

The drug tariff prices can also vary from month to month and community pharmacist 12, who had recently become the pharmacy manager and co-owner of an independent pharmacy, explained that this added greatly to their workload. *"I spend a lot of time as well finding out where we get the best prices on drugs and so on"*.

The quotes from pharmacy students and CPs illustrate the level of importance community pharmacy places on the experience of the patient. Whilst this is as it should be, the pressures that CPs and pharmacy students experience through prioritising the patients' interests are not small and may lead to significant strain for CPs and pharmacy students in their day to day work. In the next section the importance of co-workers in exacerbating or reducing the amount of pressure and stress the pharmacy team members are under is explored.

6.4.4. Working with others in the pharmacy

The narratives of the CPs and pharmacy students referred multiple times to the importance of the other staff working in the pharmacy both to the efficiency of the pharmacy and the levels of stress (and often MWL) they experienced. One stressor that was reported by both pharmacy students and CPs was staff shortage and high turnover.

"So there's quite a lot of things to do in one day. And in the pharmacy that I worked with they were always short-staffed because people just kept on leaving [laughs]. *So, yeah, that was ... I think only with more staff it* (their role) *would have been slightly better in terms of stress levels."* Pharmacy student 66

For pharmacy student 73 it was also important to work with a team of people who were passionate about what they were doing. For this participant this meant not having to "*carry the workload*" of other members of staff. Another pharmacy student noted how conflict between members of staff led to work taking longer to complete or to a lesser standard.

"If certain people would ask her to do something, she'd very quickly do it and would do it happily and well, but then I noticed that with certain other people that would ask her to do things, she would do it a lot less quickly, a bit sort of begrudgingly, and it wouldn't almost get done as well." Pharmacy student 64

The quotes from the pharmacy students above show that, as well as low staffing levels, the members of staff that are present can become a source of tension when working in a high pressured environment. This tension could affect the atmosphere in the pharmacy and several participants noted that the mood of their colleagues, especially negative emotions, would impact on their own mood states.

One difference was noted in the co-worker stressors that pharmacy students and CPs reported. When CPs talked about co-workers, it was often from the perspective of a pharmacy manager, for example when they were struggling to motivate staff or some members of staff were underperforming. Community pharmacist 60 spoke about this issue and was asked how they felt about it:

"Umm annoyed really I often do think 'Oh if I could just get somebody else in that I know will do the job then that will be good'. That is just a simplistic way of thinking about it umm frustrating really, definitely, because you can

only try for so long and then it is like I cannot get it out of you (the work performance), *I am obviously not the right person to be getting it out of you, or we need to replace you which I don't want to do.*" Community pharmacist 60

Many sources of frustration were reported during the interviews (and are discussed in detail in the next section). Frustration can be a reaction to increased WL pressures and tension and is one aspect of MWL. This is an example of a factor which may contribute to a CPs' MWL on a day-to-day basis.

Many community pharmacies employ locum pharmacists on a regular basis. The following quotes explore the relationship between locums and pharmacy staff, and the pressures locum pharmacists' experience.

Some pharmacy students felt that locum pharmacists were able to cover a pharmacy and make sure the work was done, but that having to work with a locum pharmacist increased the stress levels of pharmacy staff. Pharmacy student 4 said, "*Obviously things did go a lot slower than normal so stress is definitely, you feel it a bit more just because they are not used to the systems.*"

By contrast one independent pharmacy manager felt that locum pharmacists were a good "*release valve*" for staff:

> "*I think that is where having 11 years of locuming and listening to people because as soon as a locum walks in then it is a good opportunity for the staff to have a good old moan about the manager. And they do, do and they don't mean anything by it but it is actually release valve for them as well that they can talk to somebody else about 'She didn't quite do that or she did this'*" Community pharmacist 47

All of the CPs interviewed had worked as locum pharmacists at some point during their career. Being a locum pharmacist meant that they did not need to worry about pharmacy management. However, locum

pharmacists experienced different pressures. For example, not knowing the competencies of the staff, which made taking on the role of responsible pharmacist feel more precarious. There were pressures that were common to locum CPs as well as regular CPs, for example with MURs. *"you get in trouble because that pharmacist never does - didn't do any MURs that day" (*Community pharmacist 49).

For many locum CPs they may not have worked in that pharmacy before and therefore they will not have "local knowledge." This local knowledge included knowing the regular patients, the systems of the pharmacy, and any issues that had gone on the day before, which may need input from a pharmacist on the day that the locum is working. All the CPs and pharmacy students talked about local knowledge and how this supported their work. Some of this information can be communicated to locum CP, for example instructions can be left for locums on what needs to be done that day. However, there is information that cannot be quickly or easily communicated. The quote below explains how this can lead to errors being made with the CD balance.

> *"Things like blue scripts instalments, that kind of thing, you know roughly, oh, we use quite a lot of Suboxone, but we don't use so much of* [the] *methadone ampoules. So you know that if it looks like, "oh gosh, we've only got 10 tablets," that can't be right because we know we keep a lot in. Nine times out of 10, yeah, they* [locum pharmacists] *haven't really thought about it, or even asked. It only takes 2 seconds to ask someone that would know roughly, "No, that can't be right," that kind of thing."* Pharmacy student 73

Standard operating procedures (SOPs) and locum pharmacists were discussed in detail in several of the interviews. Most pharmacists said that when they worked as a locum pharmacist they would ask the pharmacy team how they would want to work that day, so that they fit in with the team. However, some locum pharmacists would ask the team to do things differently on the day(s) they were working and one CP likened this to

going to someone's house and *"rearranging their furniture"* (community pharmacist 49).

Community pharmacist 49 also felt strongly that locum pharmacists should be given time before they came to work to familiarise themselves with the SOPs. This was following some controlled drug discrepancies, which were found to have happened because an SOP had not been followed by a locum pharmacist. It wasn't until after this incident had happened that this pharmacist realised that their locum pharmacists had not read the SOPs.

> *"I realised that none of my locums had signed it, so this is the thing of you know, I don't expect them to read all of them SOPs but I do need them to follow the system on a few things. Umm particularly controlled drugs again discrepancies arise we realised that discrepancies were arising because one of the locums wasn't following the SOP."* Community pharmacist 41

The configuration of the pharmacy team clearly has an impact on the amount of tension and frustration CPs and their teams experience in their day to day work. The configuration of staff also affects the efficiency and safety of the pharmacy if these staff lack motivation, or in the case of locum pharmacists, are missing some "local knowledge." For pharmacy managers another concern was that staffing, time and funding were so short that it was difficult to provide training opportunities for less senior members of the pharmacy team. Community pharmacist 3, who is a manager of a supermarket pharmacy, explains how their organisation ensures the pharmacy team is able to attend training which is relevant to the supermarket, but not their pharmacy training and development.

> *"And I do think, you know depending on which company you work for, for example our company, if I don't know there's a new flavour of the month that our company particularly wants all colleagues across the store to focus on, they will ensure every colleague has that particular training and that could take 20 minutes or that could take an hour and yet from a Pharmacy aspect*

which to me is a lot more important we don't get that protected training time." Community pharmacist 3

Later this pharmacist talked about feeling *"personally, not corporately, responsible"* for ensuring their pharmacy team members received their weekly training time. This often led to this CP taking the decision that the pharmacy would run on less staff in order for this training to be undertaken.

6.4.5. Sources of Frustration

Throughout the interview transcripts CP and pharmacy student participants talked of frustrations of one kind or another. Four categories of frustration were reported by participants, task frustration, frustration with the organisation (including commercial frustrations), frustration with the profession and frustration with poor lines of communication. Task frustration was common to all participants but for CPs the main frustration was feeling the need to juggle tasks, or as participant 12 describes it being pulled in different directions.

> *"I am sure that is the same in any job in any profession but it just seems like in pharmacy because you are so bound and you have got this level in terms of service to deliver everything with reasonable promptness plus you have got the commercial aspect of it, customer retention you need sales. You know commercial reality and sales to keep the business afloat so you have got all of these. I feel like I am pulling in many - in all different directions all at once, that is why I think the frustration spikes more so than the other things"* Community Pharmacist 12

Task frustration was also discussed in Chapter five in relation to the MWL diaries and CPs' feelings of frustration, when they weren't able to tick things off their list of things to do that day. However, one pharmacy student who worked as a dispensing technician before they started their pharmacy degree commented that when the pharmacist is ticking things off their list, it means that the rest of the pharmacy team are not able to tick things of their lists leading to frustration for them. This quote illustrates

the impact that the pharmacists' WL has on the ability of the rest of the pharmacy team to carry out their work.

> **"But also the fact that I've worked as a dispenser, I know how frustrating it is and I know what really annoys the dispensers, like having a pharmacist that's just too interested in doing other things and they know that there's people waiting for these prescriptions, but they ignore them and they'll do something completely irrelevant just so that it ticks something off their list."** Pharmacy student 73

Task frustration was also linked to the amount of control that CPs and pharmacy students had over their WL. Many participants from both groups talked about spikes in WL when several patients had walked-in and were waiting for prescriptions to be dispensed, or when the piles of prescriptions were collected from general practitioner surgeries to be dispensed. Community pharmacist 12 describes this experience as *"being over a barrel"*:

> *"..the spike around lunchtime I find that then you're really just over a little bit of a barrel as to what comes in the door."* Community pharmacist 12

Another source of task frustration was not being able to take breaks because the WL was too high, or because this meant that the pharmacy could not dispense items whilst the CP was away and in some settings this was difficult. Community pharmacist 12 talks about their frustration about not being able to take a lunch break at lunchtime.

> *"The business we are in at the moment is actually quite, it is quite quiet. It is one that we are working hard to build up umm and so it really just depends on what comes in - during the lunchtime spike is quite hectic and then part of my frustration is that I don't get to have lunch until later on"* Community pharmacist 12

For Community pharmacist 3 the WL they experienced was so high that often they felt that they could not stop even for a toilet break. As this

pharmacist worked in a supermarket pharmacy it would require leaving the shop floor to go to the staff toilets which were not located close to the pharmacy. When asked how they felt about this, community pharmacist 3 said they felt guilty, they describe why below:

"I think it is guilt as well because you obviously, if you are off premises you can't, the girls can't do anything. They can't continue to sell things over the counter. They can't hand prescriptions out, they can take them in and they can talk to patients, but they can't actually physically give anything out or sell anything. So it is that whole level of guilt. Umm I don't know it is really interesting because I will almost run to the toilet sit there, panic while I am (on the toilet) [both laugh] and just think "how long have I been here?" "I have got to get back." Whereas that can't be healthy at all. And again I don't know if that is just me or if other pharmacists experience that."

HF: *"What's the guilt around?"*

"It is about the guilt from the patients I suppose because they are looking at you as a professional and the sort of comments you get back from the patients, oh as you are a pharmacy you should be open and in a 12 hour day. When I joined the company we didn't close for lunch."

All CPs reported the importance of the need to take a break to *"switch off"* (community pharmacist 49) for a few moments during the working day or to take a mental break. Many of the CP participants felt this was impossible.

One task frustration that was reported by several pharmacy students but none of the CPs was the tidiness of the dispensary. Pharmacy student 66 talked about running out of space to put dispensed items for the pharmacist to check so they would be put on the floor. Below pharmacy student 8 relates their experiences working in a messy dispensary and how it impacted on their mood state.

"Things just got out of hand, like there were prescriptions lying about all over the place and they weren't labelled. The dispensary was a mess half the

time, like orders half unpacked, boxes left everywhere, you had to climb over stuff to get to places. And when it was busy, ohhhh! Like different people, just a mess the dispensary was sometimes. And I think that's important as well, if you're in a tidy environment that's a lot better than if you're in a mess. Because if it's a mess you're like, 'oh, where did I put that prescription?' And then you're running around and it creates more panic. Panic's a very contagious thing, I think. So once you start worrying about one thing then other things seem to happen, it just like escalates and it's a whole domino trip really". Pharmacy student 8

One reason why a messy dispensary may be more of an issue for pharmacy students is that as pharmacy students they are taking on different roles to that of a qualified pharmacist. However, this difference illustrates the importance of taking an individual approach when considering what factors might be increasing an employee's WL or stress levels.

Both CPs and pharmacy students reported frustrations with the organisation(s) they were working with. Again some frustrations were experienced by one group but not the other because of the differences in the roles they were undertaking. Several CPs who worked either in independent, or chain pharmacies felt frustrated at the level of funding available for pharmacy services. Community pharmacist 12 described it as both a commercial and a professional frustration:

"The frustration ahh slightly commercial frustration but also professionally if you want to be doing different services which we do as a profession - fantastic but you can't take your eye off the ball in terms of dispensing side of things and do over the counter trade and you know, simple checking prescriptions. You just can't do it, so the financial funding of pharmacy is huge, it is like a lynch pin really because if that was better, pharmacists were better funded you can employ extra pharmacists or you could afford to have more locum cover so that you could have a day or a morning or whatever where you do clinics. I mean we have one day every other week basically now where the

second pharmacist and I work alongside one another purely just to try and do as many MURs or services as we can. But - even that - the business it is touch and go whether the business can afford that in the early days but that is the big frustration - the financial funding." Community pharmacist 12

The other commercial pressures that CPs and pharmacy students experienced were targets. The targets that participants had to meet varied between organisations. However, community pharmacist 29 reported the most targets. On a daily basis they had to meet advanced and enhanced service targets, patient waiting time targets and regular mystery shopper visits. Some of these targets, for example those relating to MURs community pharmacist 29 was pleased to meet as they enjoyed providing these services. However this CP was frustrated by the mystery shopper and patient waiting time targets as they felt the data was collected by head office in a way that didn't represent the performance of their pharmacy. For example in the quote below, this pharmacist talks about the frustration when patient wait target performance decreases because they have had a day off:

"The performance for most days is actually within target or less than target but then if you, I get frustrated when I see on days when I'm not there, and the waiting time goes up. So anything that we build we would disappear." Community pharmacist 29

Whilst discussing targets, community pharmacist 29 said that since they had started working in a target focussed setting it had slowed their work down. One reason for this may be the lack of autonomy that this pharmacy manager felt they had in their role.

"I mean I've worked in the past for a different employer where there wasn't [sic] *targets for me 'cause I was a relief* [pharmacist]. *So there wasn't a target as such and kind of I was doing more. Where you get targets given to you it slows you down somehow it actually does slow you down."* Community pharmacist 29

Pharmacy students also spoke about targets, and several of them mentioned customer satisfaction targets. Again, this participant reports their frustration that the targets don't reflect the work or the performance of the individuals being measured.

> *"I'm more than happy to talk to people and serve on a Sunday, but if I had a choice I'd probably go to the back and do the dispensing and that kind of thing, whereas they like to go the other way. So then it looks like I'm not doing anything, although I am, but just maybe not with the customers. And then it always makes it look like, oh,* XXX [name of pharmacy colleague at the same community pharmacy chain] *over there who's had 10 mentions this week and,* XXX [name of pharmacy student 73]*, you haven't even got one, so you must be doing something wrong. So, yeah, it can be quite frustrating at times because a lot of the work goes unseen, but then that's like everyone, you've all got your unsung heroes and whatnot…so yeah."*
> Pharmacy student 73

Another frustration for this pharmacy student participant was that handing out customer satisfaction surveys de-valued the care they were providing. This was a significant source of tension for this pharmacy student when they were at work.

> *"Yeah, it makes it look all really fake, like you only do it so that you can then ask someone for feedback. And err it's not ideal, especially when you give something really good, like you notice someone's not using their inhalers or their creams right or something like that, and they come back in a few weeks' time and say you really made a difference. But when you first did that it looked like you only gave that kind of information like as a trade-off for some really good feedback kind of thing. So, yeah, I don't like that."* Pharmacy student 73

CPs also reported several frustrations with the pharmacy profession and the role of the CP. For community pharmacist 47 this was related to the amount of authority and control general practitioners have over community pharmacy and the inability of the local pharmacy committee

(LPC) to support their contractors. This is explained in more detail in community pharmacist 47's own words below.

"It is just the way that, because the NHS has developed, doctors have an awful lot of authority, and say, and control about the way things go. And particularly at the moment we are going through a real frustrating time as a pharmacy because the surgeries can be one and a half miles away from where we are so instead of being just down the road they are a mile and a half away and they have opened - well they haven't - but a pharmacy has opened in their building under their contract which they now choose to favour. So that is the real thing that I am really frustrated by. Mainly because I know I can't do anything. But when you go to other pharmacy bodies - I am going to say the LPC because there is no other way to say it - and as individuals they are very professional people they are very good, very with it. But when they turn round and say 'oh we're a toothless tiger.' 'Why? Why are you? You know, why have you let yourself be put into that position?' This political body, you know 'you are there to represent my interests. Well not just mine but every other contractor that's there and you are telling me you can't?'" Community pharmacist 47

For community pharmacist 47 this also limited their ability to make the impact on patients' healthcare that they had used to.

" I feel at the moment particularly just because the situation going on, I know I want to be part of the healthcare in the town that I work, I want to make that impact, I want to use my professionalism and I want it recognised, I want to be recognised for it but I find no way of doing that you know people are grateful and users and we have got a lot of customer loyalty and that is all lovely on an individual basis but really you know I want to be able to turn around to the PCT [primary care trust] and say look this is what I can do unless we have a real benefit and why can't I?" Community pharmacist 47

Community pharmacist 41 expressed frustration over the way pharmacy services are funded by the government. In their perception this gave CPs mixed messages about the role they wanted them to take.

"So you feel as though they [the government] *want us to be shop keepers but they don't want us to, but they want us to be professionals but they don't want to pay in the way that you would expect a professional to be paid".* Community pharmacist 41

Another source of frustration was communication with other healthcare professionals. Difficulty contacting prescribers when there was a problem with a prescription was a frustration that most of the CPs expressed. Community pharmacist 3 felt all was needed was a direct line with surgeries which CPs could use to contact prescribers on.

"A real key area - if communication channels - even if you just had email access to the GPs, or prescribers, or a direct dial phone number where you could speak to them. One of our local surgeries has a direct dial number so you don't have to wait for the recorded message and press 1,2,3,4 and yet when you ring that direct dial number 'this is an emergency number doctors only.' 'Well this kind of is an emergency you know! I have got a prescription here for an antibiotic, I don't think the dose is appropriate and I need to speak to the doctor urgently. I have been on hold oh 20 minutes on your other line and the patient is getting angry with me, but I do need to speak to a prescriber before I go any further with this.' And you still get told to put the phone down and dial back on the other number." Community pharmacist 3

Participant 47 wonders whether the reason CPs experience difficulties getting hold of general practitioners on the phone is because they are only ever ringing them to tell them they got something wrong.

"I think that is the other thing because we usually only phone them up to tell them that they have done something silly, so that is a very negative thing isn't it, we never phone up to say good morning good news out of that thousand items you prescribed last week you only made one mistake." Community pharmacist 47

CPs who did not express frustration with lines of communication were those whose pharmacies were based within a GP surgery. This was true

for community pharmacist 41, however the pharmacies they had worked for in the past were not always in GP surgeries and this CP explains how they built strong working relationships with GPs.

> *"The shops that I managed when I was younger were much further away from the surgeries umm but after I think the third - the second pharmacy - I built much stronger relationships with the GPs. Umm just because I am that sort of person but I had always actually taken the prescription to the surgery if there was a problem and talked to them about it after I had finished or at lunchtime so that I had a face to face discussion. I didn't - it wasn't just over the telephone because you have got to build relationships. You can't expect someone just to speak to you over the phone just because you are you* [the pharmacist] *umm they have to know you too."* Community pharmacist 41

This section outlines just how many day-to-day frustrations CPs and often pharmacy students experience when working in community pharmacies. At times these frustrations are qualitatively different for the two groups of participants, but this likely reflects the difference in the roles that pharmacy students undertake when on placement. The next section considers the pressures that CPs and pharmacy students experience that may not cause frustration but cause some form of tension.

6.4.6. Sources of Pressure

Pharmacy students and CPs also talked about experiences which didn't cause frustration, but were significant pressures. The national increases in dispensing activity year on year were discussed in Chapter 1 and this was a significant pressure for many pharmacists. Several CPs referred to the "dispensing treadmill," the pressure it causes and how it can be near-on impossible to leave the pharmacy at the end of the day without leaving things to be completed the next day.

> *"I mean that is absolutely in some places it is impossible but I like to go in in the morning and finish all the work on that day. And in fact many years ago before I even bought my pharmacy I spoke to a chap who had a pharmacy and*

I was saying "oh I am thinking of buying a pharmacy what do you think?"
"Can you give me some advice?" And one of the things he said was "always
make sure you finish your days' work in the day." And I always tried to do
that, but some places it is just impossible these days it is like a relentless
treadmill and things are left to the next day." Community pharmacist 49

Frustrations over commercial pressures have been discussed, but the following quotes illustrate the other impacts that these pressures can have on CPs and pharmacy students. Below community pharmacist 67 talks about anticipation of a telephone call to find out whether they have done any MURs yet.

"The last thing you want is someone putting constant pressure upon you
especially if it is already busy or it is already hectic the last thing you want
to be doing is thinking oh I might get a phone call in an hour time and I will
have to feedback how many MURs I have done and if that is zero you aren't
going to feel too great about it so I guess it does make an impact."
Community pharmacist 67

In this quote this CP gives a sense that it is one pressure on top of another pressure on top of another. The experience of multiple pressures was common to all CP and pharmacy student narratives. However, for some CPs the pressure to meet the professional clinical service targets did not cause tension, even for community pharmacist 29 who reported having to meet the most targets of all the CPs interviewed.

"In terms of the MURs and other professional services there is a bit of
pressure there from the company and you feel it all the time, but to me it's
something that I like doing so it doesn't actually make a lot of difference to me
'cause when I do it then there's no pressure." Community pharmacist 29

Community pharmacist 3 also enjoyed providing MURs and other services, but spoke about the perils of success in meeting targets. Success could mean to greater pressures the following year.

"But I think you know with a lot of things in pharmacy, it is just turning into you know, another business thing of well you have achieved this output this year, therefore we are going to ask you to do that again with an extra 10% on top. And pharmacy doesn't necessarily work like that." Community *pharmacist 3*

For Pharmacy student 8 one placement experience was all about business. They described the culture in this pharmacy chain as "sell, sell, sell."

"Yeah, they're like you must do like so many MURs a week, this must happen, we must do so many items a month, this is what we're going to push for this month, this is a promotional offer for this month, we have to sell this, let's sell, sell, sell. Pharmacy student 8

Pharmacy student 66 spoke about having meetings with their placement tutor every other day to report how many MURs they had organised and how many customer satisfaction surveys they had given out.

"It's the MUR that needs to be done and they want us to hand out as many customer service surveys. Yeah. So there are like targets that we have to meet, and the pharmacist will be like how many have you done? And he'll be having a chat with me like every 2 days to check on how many I'm doing." Pharmacy student 66

Pharmacy students also felt pressure because their performance in relation to customer satisfaction and MUR targets affected their manager's bonuses.

"Although I love community pharmacy, I don't know whether it's XXX [name of pharmacy chain] *in general, because obviously there's a lot of competition, but the one thing that really gets me is the like customer care, customer feedback. Because obviously people are always worried about their bonuses. It's like the manager, the worst thing is when you get a manager that's not a pharmacist, so they don't even understand that side, they just want figures, they just want bonuses.* Pharmacy student 73

These were pressures imposed on CPs and pharmacy students by pharmacy organisations. The next quote considers the pressures that community pharmacists place upon themselves, community pharmacist 47 talks about pharmacists needing to stop taking on responsibility for the world.

> *"I do really think that you have to remind yourself of that because at the end of the day you are the only one that loses out it is only a job at the end of the day, I know pharmacists forget it but it is only a job, there comes a point where we are not responsible for the world. And I do think as a profession we do take on too much responsibility because we are the end person. We are the ones fronting that person and we know that, that old lady is going to be on her own with no medication and nobody there and we want to take care of them. And I think that's our strength but it is our weakness because it then ensures that we get bullied into things that we shouldn't by other professions. And perhaps even within our profession because we care too much in a way. And we don't want to leave that person on their own. It is quite hard to do that as well."* Community pharmacist 47

This quote in many ways relates back to those reported in section 6.4.1 above about CPs needing to know themselves and where to draw the line.

The responsible pharmacist regulations also caused pressure. For community pharmacist 47 this was because they felt that these regulations had confused corporate responsibility with individual responsibility.

> *I think when you go into a premises as the pharmacist you need to know what is your responsibilities and what isn't, the trouble is I think they confuse what corporate responsibility with individual responsibility and they merge the two and I think they need to sort that out because it is really gave a get out clause for a lot of the big corporations."* Community pharmacist 47

Concerns about the responsible pharmacist legislation were also important to the decision whether to employ an accuracy checking technician (ACT) in the pharmacy. However, for community pharmacist 12 their WL was a

greater pressure so if their pharmacy could afford to hire an ACT this concern would be minor compared to the benefit they would gain.

> *"Absolutely, I think the thing that you really need to iron out and you won't find out until it is tested in law is where the responsibility lies if an error goes out so that is a tricky one, because as far as I am aware and I haven't looked into it really recently the pharmacist would still be equally liable as the checking technician and that is not right but those are sort of the minor worries for me because the benefit of having an ACT there for me would actually be huge."* Community pharmacist 12

Other policies and policy changes had caused pressure through an increase in workload for some CPs.

> *"I think a particular new, err new process, that came down probably about 8 months ago has added at least 2 hours onto our end of month process. And yet you don't get any more hours in the day to do. So that the question was asked* [to area managers] *do we get more hours? And the answer was "well it is not just our company it is across community pharmacy as a whole, everyone is managing to do it somehow so you should as well." But of course everyone else isn't managing to do it or if they are managing to do it something has got to give somewhere, and bringing it back to umm your study maybe it is a safety aspect. It would be interesting to correlate the number of incidences with you know, that are happening after a new process has come out."* Community pharmacist 3

As the role of the CP, and the services that community pharmacies are offering have changed significantly in recent years, many CPs and pharmacy students spoke about the pressures around keeping up to date. This added pressure left community pharmacist 3 feeling despondent.

> *"You have got to take time out to sort of retrain yourself and, read things through and then explain it to your staff. Which is, you know when you have got the pressure from the company, or maybe the guidelines have changed then you get despondent. And you think gosh well have I really got time to go*

through all this training and re-brief my staff? Actually I am going to put MURs on hold for a couple of weeks and focus on something else that needs to be done." Community pharmacist 3

A pharmacy student also highlighted that the trouble was not just the rate of the changes, but that they were never published in the same place, making it even harder to keep up to date.

"Yeah, they're crazy. All the time, like there's no way of just learning I mean, even if you were to just rote learn them and they didn't change very often at all, it still would be a task just to learn them all. But the fact that they're always changing, and they're not even in one place to find out what's going on, [**ok**] *I think that's my main trouble…"* Pharmacy student 73

Pharmacy student 73 gave an example of when they realised through their lectures on pharmacy law at University that the community pharmacy team that they worked for was not up to date with current legal requirements with regard to emergency supplies.

"I did notice a few things that my pharmacy had been doing wrong. [**ahh**] *So I actually went home ... because when they first taught it me, I was like, no, that can't be right, because we'd been doing it this way. Umm and then for example, emergency supplies, you have to make a copy of them if they're faxed over, for example.* [**Ok**]*They hadn't been doing that. So I went home one summer and was like, guys, you're doing this totally wrong, this is breaking the law, let's sort this out. And they were like, oh God, we hadn't even noticed."* Pharmacy student 73

In this section several pressures that both CPs and pharmacy students experience have been highlighted. Pharmacy students had yet to experience the pressures that come with the responsibility of being the pharmacist, but had all experienced high levels of pressure to meet company targets and trying to keep up to date with policy changes. In the next section, quotes are presented which illustrate the strategies that CPs and pharmacy students have developed to cope with pharmacy pressures.

Coping with Pressure

When faced with pressures individuals will in the first instance seek ways to minimise, or cope with these pressures. The aim of this qualitative study was to learn about any coping strategies that CPs and pharmacy students were already using. Very few of the pharmacy students felt they had developed coping strategies, but most of the CPs' and pharmacy students' narratives mentioned organising the WL as a tool for coping with the pressure. Some described this as a means of "putting control back into the system" (community pharmacist 12). In the quote below community pharmacist 3 speaks about prioritising their WL.

> *"I always like to prioritise things, and as I will reemphasise to my store management team, MURs are an advance service, so you make sure you have done everything that you need to do that is an essential service, before you contemplate doing an advanced or an enhanced service. So my PCS* [prescription collection service], *my walk in prescriptions, my destruction of patient returns that has always got to come first. My advice over the counter has always got to come first. Once I have done all of that then if I have got any time left then I will prioritise MURs because obviously its pharmacy is a business and the remuneration for MURs is quite high, you know it is all pure profit technically."* Community pharmacist 3

Another CP spoke about planning the most safety critical tasks for when they knew their WL and the pressure would be lower.

> *"I have never really felt like the pressures later on in the day particularly that late which is why I try and do it* [the methadone] *between sort of around about 4ish something like that because the last hour you're just sort of winding down and preparing, writing yourself lists for the following day".* Community Pharmacist 12

All the CP participants used the phrase '*in the back of my mind*' several times during the interviews and it seems that they all found it necessary to hold information in their heads so that they would not forget it. In order to do this participants' must rely on their working memory processes so this

strategy would likely lead to extra mental demands. Community pharmacist 12 used the expression in the context of a busy period at the end of the day when there was a short time frame when there would be fewer staff in the pharmacy:

"Yes we have got quite a lot of things that we are doing in the afternoon umm and I have got the way my staff are structured at the moment is that some start early finish early and some start middle of the day and finish you know 5 and there is one that works right through until 6 and we try and get as much out of the way by sort of 4.30, 5 if possible because I know that it is going to be a little more stretched from 4.30, 5 o'clock until 6 o'clock. So there is always in the back of your mind that you need to get everything done." Community pharmacist 12

Community pharmacist 3 also used this term:

"You have always got that constant thing in the back of your head thinking gosh I must get this training or this new product has come off prescription. I need to learn about that it is on our shelf but I actually haven't had time to do the reading, I hope that nobody comes in and asks me about it." Community pharmacist 3

Later community pharmacist 3 describes a mediocre day as having "4 or 5 chunks in your head"

"Oh yes yeah absolutely you know I guess if you go into sort of a mediocre day where everything is kind of average then I guess maybe you have got like 4 or 5 chunks in your head of things that you have got to do." Community pharmacist 3

The number of chunks that community pharmacist 3 is holding in their mind is interesting, as working memory capacity limits are often also described in terms of chunks of information. It is thought that the capacity limits of working memory is 7 ± 2 chunks of information (Miller, 1956) indicating the amount of MWL that community pharmacist 3 may be using just to remember what needs to be done that day. However, at the end of

the month when there are extra pieces of paperwork to be submitted and other end of month tasks to be completed community pharmacist 3 then describes it as "*just all a whirr but it is still there in your subconscious the important bits that you need*" [Community pharmacist 3].

Instead of holding the to-do list in their head, community pharmacist 41 made themselves piles of things that needed to be done which they would later sort through. Unfortunately, the significance of the pile was not always noted by other members of the pharmacy team.

> "*I tend to make myself lists but then I also make myself piles which some people who I work with get very cross with because they see a pile and think that should be tidied away but in my head it means I know I have got to sort through that to then make sure I haven't missed anything for the following day or missed anything about a patient.*" Community pharmacist 41

When CP participants talked about the pressure of community pharmacy all of the community pharmacists talked about needing to be "*in the zone*" (community pharmacist 41), "*not switching off…you have got to stay on*" (community pharmacist 67). For some participants this was about maintaining focus on everything that was going on around them so that they could have everything ready for patients when they came back.

> "*It is constant, it is just constant in like you don't want to switch off because obviously that has an effect on everybody. But you have got to stay on but you have got to know what is going on outside, you have got to know what you are doing and you have got to know what the person next to you is doing because we had the order come in at that point in time. So everybody who hadn't had their prescriptions since yesterday will 9 times out of 10 be coming back in the next hour or so, so you want to be in a position where it is ready for them.*" Community pharmacist 67

Community pharmacist 67's comment described trying to maintain their situation awareness which can only happen if MWL isn't too high (and therefore sufficient mental resources are available). However, this quote

gives a sense of how much CPs are trying to attend to at any given moment and pharmacy student 8 described this level of focus and concentration as tiring:

"You've got to try and like drive yourself to stay focused and make sure you can sustain the level of concentration. But that is quite tiring." Pharmacy student 8

Whereas community pharmacist 3 "*thrived*" on this intensity of work:

"As soon as I am there [work] you know, you know, you are in the saddle you are doing it, you are up and running everything is going on around you, and you just sort of thrive on it." Community pharmacist 3

This pharmacist also described their work as a "*complete release*"

"Yeah absolutely not taking into consideration your personal circumstances outside of work - which you do cut off completely because you have to unless it is something really intense."

HF*: "So you find that you can do that?"*

"That is probably why I love my job so much it is a compete release. [laughs]"

For most of the CPs the difficulty was not being in the zone, it was getting back into the zone on a morning, after a break, or after a holiday. This leads to the pressure building much more quickly:

"I think when you have not actually worked for a while I think it is very hard coming back into practice. If you have been doing another role or you have been off on holiday. It's umm, you come back feeling so relaxed that you actually aren't in the zone, I find it very difficult sometimes. Umm and it isn't on purpose that you arrive like that but you just you have changed and you are not up to speed and so then the pressure can start to build much more quickly." Community pharmacist 41

Community pharmacist 47 said the danger of quiet times is that pharmacists are no longer in the zone,

"You do have the quieter times and that is when it is most dangerous actually. That is probably when you have switched off because you have had a quieter time and then you have to go back into it. [Later they said] *And I find that I come back after my lunch and I find I had that half an hour it almost feels like a Monday morning because you are not quite in that work mode, reboot and it is quite interesting. I have noticed that a couple of the mistakes that I have made have been in that sort of half an hour. Monday morning is Monday morning and you are a bit more aware that you have got the Monday morning feeling but if it is Tuesday afternoon."* Community pharmacist 47

For this reason community pharmacist 60 is reluctant to take a beak so that they don't lose their motivation:

"Sometimes I feel that if I just carry on with it, eat and carry on I don't lose the motivation. I am still ok at the end of the day really umm so it is having to build yourself up to it again after, which can sometimes be more of a challenge I think than not having a break at all. It is kind of going there for the morning again that is what it is like it sounds silly." Community pharmacist 60

Sometimes the WL became too high for CPs and for community pharmacist 60, these times were when there was a large number of patients waiting in the pharmacy. To deal with these times, community pharmacist 60 had a rather unusual and drastic coping strategy:

"when you just think I am really stressed at the moment I just need a couple of people to leave. Before actually I have done the fire evacuation as well!"

HF*: oh?*

"Yeah well we have to do it every six months anyway."

HF: *With patients?*

"Yeah we have to do it [the fire alarm] *when it is busy, at a busy time so I just stick the fire evacuation* [on] *and get everybody out for peace of mind. Because then you can get out of the shop, stop for a few minutes calm down and then 5 minutes later get back in the shop sort it all out and start the process. I got that from my tutor he played it once when I was there and I thought that was the best idea in the world because you have to do it and when, at the busiest time it is when you are going to get the best results, so it worked."* Community pharmacist 60

In this section quotes from CPs highlighted the ways they had learnt to manage some of the pressures in the pharmacy. This includes organising, planning and prioritising WL and using the fire alarm to clear the pharmacy when it gets too busy to achieve peace of mind. The quotes also described needing to be mentally focussed and in the zone, in the next section CPs and pharmacy students describe their experiences of MWL.

6.4.7. Experiences of mental workload

A general discussion about MWL took place and throughout the interviews participants used words or phrases to describe what MWL meant to them. Some examples of their descriptions are given below and refer to both how it felt to them to be mentally overloaded, mentally under-loaded and also those things that contributed to MWL. A key aim of this research was to learn how CPs and pharmacy students described MWL. Emboldened text is used to highlight phrases that suggest MWL itself.

Community pharmacist 67 talks about what increases their MWL and how this makes it harder for them to concentrate. They described their high MWL as "***the cogs sort of break up***." One scenario that makes the cogs break up is dispensing and checking work left from the previous shift which they then have to try and do whilst ensuring everything is prepared for methadone patients and other patients:

*"But I guess for instance I come in and there is a whole stack of stuff then that is actually a workload sort of thing, so that is when **the cogs sort of break up**, they just it sort of goes to pot, that is when it is so called harder to concentrate on what you are doing at that point in time without thinking about everything else, that is when it becomes harder." what used to happen when there used to be a locum there is for instance we might have a whole load back in the afternoon you know about 4 or 500 scripts back yep, instead of getting the aim to get it done that day they will be left to the next day yeah as in obviously some of it will be done then it will be for the next day in the morning, yeah so you can come in, in the morning you have got that to deal with alongside your so called methadones, alongside your queries so it just, like I said **cogs start blowing up."** Community pharmacist 67*

Community pharmacist 3 also described MWL:

*"I think it is attention that is how I would describe it yeah **just an overload in your head and having it all sectioned up**." Community pharmacist 3*

During the interviews participants also described the different aspects of MWL. Frustration was the aspect of MWL which was referred to by both CPs and pharmacy students with the greatest frequency. This aspect has already been covered above but the five other aspects are discussed in turn below.

Experiences of temporal demand (time pressure)

Community pharmacist 49 found that time pressure increased their likelihood of making DEs so they would deliberately slow down:

"One thing I do do, if it becomes very pressured, I would deliberately slow down. And in fact if I have made any mistakes it is always because I have done it too quickly." Community pharmacist 49

Pharmacy student 73 speaks about what causes time pressure and how they manage this when they are working in a community pharmacy:

"So say I have more tasks to do, say there's a massive pile of deliveries that needs to be put away and there's a massive queue of prescriptions and people are waiting on the till, I just try to work as fast as I can. Yeah. That's what I try to do."

HF: *How do you do that, how do you make yourself work as fast as you can?*

"Err ... [laughs] ... what do I do? I just work ... say normally I'd walk slowly to get the item on the shelf, I'll more like jump to it [laughs], go as quickly as possible. Yeah. I mean, even if I do that, it's not really going to make that much of a difference, because I've only 2 hands and only 1 brain. So I don't think it makes a lot of difference. Probably that just ends up ... it will probably end up that I'll make a mistake because I've rushed something. It's quite important that I get the prescription right, so I don't think it's the best way to do it, to be honest [laughs]. Yeah. " Pharmacy student 73

Community pharmacist 60 talks about how they feel when it gets to 4 o'clock and it is almost the end of the day. This is a time when they feel there is less time pressure and for them this time of day means that they can focus better:

"Yeah I think so because I know where I am at with this and I know it is not going to be manic during the next hour and I can relax more. And I think I am probably more effective during that time as well because I feel that I can focus better on things, although maybe I am a little more tired I think I can focus on thinking." Community pharmacist 60

Several CPs talked about feeling resentful towards the time pressure because there wasn't time for the details, or to spend time with patients.

"I feel resentful. I suppose sometimes if I am around the back and I am trying to get my head down, and I am trying to finish checking, bagging and putting away all of the repeat prescriptions and I have walk-ins or somebody that wants to come and talk to me, and I really, you know, I don't feel happy

that [I] *haven't got time to go and speak to them in depth as much as I would like."* Community pharmacist 3

Time pressure also stopped pharmacy students from recommending patients for MURs:

"It's quite difficult, because I've been asked when I've been doing my summer placements, oh, can you look out for anyone that would be a good MUR candidate kind of thing? And there will be some that I will think, oh, they'll be brilliant, stick the MUR label on their prescription or whatever, hand it over to the pharmacist - and I just look out the front or look at the side for all the stuff I've got to check and the people, there's no chairs left, there's so many people waiting, and you just think there's no way in reality we can do that now, you just think I'll just have to let it go. And then out it goes, just like normal, because there's just no way that you could fit it in." Pharmacy student 69

Experiences of physical demand

Pharmacy student and CP participants also talked about the physical demands they experienced during the interviews:

"I particularly liked the fact that you put the physical demand in there as well because I always run around like a headless chicken in our place. So it is knackering quite physically at the end of the day so I like that part particularly in there." Community pharmacist 60

The layout of the pharmacy was particularly important in determining the amount of physical demand experienced:

"Because my pharmacy is very small it isn't that physically demanding. Umm and most of the stock is kept in continental drawers so you are not rushing from one place to another to collect things. So it's not, and everything is very organised in the collection, so you are not searching and searching for things its clear. And so you don't feel as though it's physically that demanding." Community pharmacist 41

Pharmacy student 73 also found the way medicines were stored in the pharmacy they worked as key to reducing their physical demand.

"We've got a ... I can't think what it's called, I can't remember what it's called now, but it's like a huge Christmas tree in the middle of the dispensary, the spinning ones, umm and that keeps all of our most popular drugs as such on there…we can spin it, so we have like multiple stations around it and as long as - I mean, I've been told off for whizzing it far too fast, because I'm on fast forward all the time - so as long as you don't take someone's hand off and you click the doors in properly, being able to move the stock to you really helps. And so when you have these galleys that you have to weave in and out of people, pull open drawers, don't hit people on the head, that kind of stuff, I don't think they're really very ideal….And, like I say, you make it work for you, so you bring the stock to you. So I think that helps. And it reduces footsteps, which obviously makes things a lot faster. You've definitely got to have flow, though, you've got to have you start here, you dispense here, you check here, you hand out here, you've got to have some kind of ... because it is chaotic otherwise, running back and forth. And I think then you obviously increase your workload, increase your stress, all that kind of thing." Pharmacy student 73

Experiences of mental demand

The tasks which caused the greatest mental demands were also discussed by participants. For community pharmacist 29, mental demand was related to the amount of the work in general, but also processing specific pieces of information when carrying out the clinical check:

"In terms of the mental demand I think what I've discovered is actually related to the workload. So I tend to as part of the clinical check, I tend to focus more on the strength, and the age of the patient, and things like that so I think that requires a bit of mental work and processing all this information and assessing them." Community pharmacist 29

Community pharmacist 60 who has diabetes spoke about mental and physical demands they experience and how they related to drops in their blood sugar levels:

> *"So at that point usually between 11 and 12 I will need a little bit of lucuzade, a lot of that is because of the physical and mental demand of it. It is really weird the only things that bring my blood sugars down - there are 3 things - exercise, insulin and inorganic chemistry, that's true!"* Community pharmacist 60

This experience that community pharmacist 60 reports is not unsurprising and links to the physiological measurements that researchers take of MWL that were outlined in Chapter 2.

For most participants the feeling was that the greatest mental demands came from the pressures described in section 6.4.6 above.

Experiences of performance concern

Participants also spoke about performance concerns and how they varied throughout the working day. These issues were also discussed in Chapter 5 in relation to the MWL diaries. The quotes used in Chapter 5 illustrated that performance concerns for some CPs were related to how well they were progressing on their list of things to do that day. For pharmacy students, performance concerns were, as would probably be expected, very different. Most of the pharmacy students talked about this in the context of comparing checking and dispensing classes at university with real-life pharmacy practice.

> *"They're more stressful, I think, than actually in work, just because you get marked on them and you're quite conscious. Or at least I found the second year practical classes a lot more stressful than the third year, which is actually, I think ... oh no, because the third ones don't actually count for anything, so it doesn't feel as stressful. But knowing that your mark depends on how well you do kind of just adds a bit more stress to it."* Pharmacy student 66

Experiences of effort

None of the participants talked about the effort involved in tasks directly, but there was a suggestion that some tasks were more mentally demanding, but less effortful because they kept their attention. More repetitive tasks were harder because participants had to invest more effort to keep their attention focussed. This is described by pharmacy student 8 below:

> *"Err ... any sort of ... err ... repetitive ... err ... repetitive task is quite tiring, I think. Because it might be difficult, but it's hard to like stay focused and stimulated. Maybe it's just that I've got a poor attention span. Like talking to patients, like trying to recommend stuff from over-the-counter, that's fine, I wouldn't get tired by that, I could probably do that all day like you know trying to give them the right thing, because you're engaged, it's stimulating, whereas like if you're doing the same thing over and over again I think it's a struggle to stay focused. That's what tires you out in my opinion from my experience as well."* Pharmacy student 8

Non – pharmacy stressors and mental workload

To end this section, two quotes one from a CP and one from a pharmacy student who talk about having other things (not related to pharmacy) on their mind and how that affects their perceptions of MWL and ability to do their work.

> *"I certainly worked 12 hour days for 3 days in a row with a commute of about 8 minutes from where I work [laughs] for 5 years. And then suddenly thought actually, I can't do this anymore. But I think you just get into the routine of it. But you know if you have got other things going on in your personal life that take an amount out of you then you certainly notice. And if you have got other demands within your business and things that you need to do corporately that takes another chunk out of you."* Community pharmacist 3

Pharmacy student 10 talks about having exam results on their mind on days that they were working in a community pharmacy and difficulty concentrating on the pharmacy work.

"I remember during 2 of my summer holidays when I was working in community pharmacy when I've always had other things in my mind and I haven't been fully focused on work. For example, I think, when exam results were out on the same day as I was working, and I just couldn't concentrate as much compared to any other normal day." Pharmacy student 10

In this section the words that CPs and pharmacy students use to describe their MWL were reported. Participants also spoke about the different aspects of MWL and what factors were linked to increases of each type of MWL. The next section looks at the impact of interruptions and distractions on CP and pharmacy student's MWL and DEs.

6.4.8. The impact of distractions and interruptions

One of the aims of this study and experiment 2 reported in Chapter 4 was to explore the impact of distractions and interruptions on CPs and pharmacy students' ability to carry out their work. The following quotes from participants illustrate the frequency with which interruptions and distractions occur in community pharmacies.

"there have been times before where I have had to pull the cord out of the phone to stop it just for a few seconds so that I can think about what I am doing, if I am checking a controlled drug and the phone is going and then someone is asking me to do something at the same time, it is just too much and usually at that point I pick the drugs up pull the phone out and sit in the office or something and check it there, because that is the only place I can get peace of mind and actually focus on the task." Community pharmacist 60

This is another quote from community pharmacist 60 where they talk about needing to get "peace of mind." Giving an indication of the difficulty this CP sometimes has in finding a place where they can give their work the focus they feel they need to.

Pharmacy student 10 reflects on the difference between their experiences of accuracy checking in experiment 1 (reported in chapter 4) and what it is like when they are working in a community pharmacy:

> *"Yeah, they do actually, because I found that when I was doing the checking exercise that you set me, I felt like in that I made next to no errors, I could just focus on what I was doing without any distractions around me. But when I've been working in community I've always had quite talkative colleagues, so they can be a distraction. Or when you see someone that you know come in. Yeah, so there are plenty of distractions when I'm working in community and that can sometimes cause me to make a mistake or forget about something."* Pharmacy student 10

This student felt that the distractions they experienced in real-life pharmacy practice increased the likelihood that they would make a DE. Community pharmacist 3 describes what happens when their pharmacy closes to patients at 8 o'clock in the evening and how this allows them to enter a completely different mind-set and for their *"ears to go quiet."* When this happens they are able to get through their work a lot faster. Indicating the level to which these interruptions and distractions impact on their productivity throughout the day.

> *"As soon as 8 o'clock comes and the pharmacy is shut, yes patients still walk up and down the aisle and everything, but I'm in a totally different mind-set because my ears almost go quiet because there is no interaction out the front. Even when there isn't interaction out the front I am still like a meerkat* [laughs]. *On my tip toes because I am quite short looking over the front every 30 seconds in case there is someone out there that needs serving and I need to shout at them and my girls go and serve them.* [pause] *8 o'clock comes, totally different game where I could have a bench of stuff to check that might take an hour and a half to 2 hours when we are open and the phone is ringing and people are asking you questions and listening, I can probably do that in half an hour."* Community pharmacist 3

All participants in this study talked about interruptions and distractions. CPs and pharmacy students also all agreed that this was part of the CP role as they had to be monitoring everything that was going on in the pharmacy, the advice that was being given and for any problems that might be arising.

6.4.9. Dispensing errors

Throughout each section factors which lead to an increase in DEs were identified, for example distractions and interruptions, members of staff not following SOPs and time pressure. The first quotes in this final section describe the impact of making a DE on the CP or pharmacy student. Community pharmacist 47 describes it as losing your nerve.

> *"I think as pharmacists you lose your nerves, I think when you get to a certain point in your career when you are older you lose your nerve and you can see it with some of the pharmacists because it impacts on the way they work, they become very scared and it makes them less effective as pharmacists I think. It influences and colours how they work and how they deal with people and how they deal with situations. Yeah, yeah definitely and they almost and they will leave things umm I have seen it as a locum, I worked with a chap as a locum I used to go in and locum and he used to leave me to make a lot of the decisions he just couldn't make it, he had lost his nerve."*
> Community pharmacist 47

Pharmacy student 64 perceived themselves to lack confidence in their work, and often this led to them changing what they had done and making an error.

> *"I think something could be completely right, but if I'm not confident about it I'll go back and check something and change it, and then it could even be potentially wrong after I've made the difference. And so I think, yeah, believing that you've made the right decision and being confident that you have, and being confident that what you're doing and what you're thinking about something is correct, yeah, it makes a huge difference."* Pharmacy student 64

Community pharmacist 47 felt that if no harm was caused it was just their *"professional pride"* which had taken a knock, and community pharmacist 41 also wasn't concerned with the impact of DEs on themselves, but spoke about the importance of being honest when a DE was made.

> *"I think actually being honest and reflecting on things and not hiding things is the most important thing with pharmacy because it is so easy to gloss over a mistake. And umm not admit that you think you might have picked the wrong thing or done something wrong, you have got to always face up to it and say so if you are not sure."* Community pharmacist 41

Later community pharmacist 41 also spoke about how they had changed their practice in their pharmacy to insist that the member(s) of the team who made a DE completed the error reporting form on the computer system themselves so that they could learn about why they made the DE.

For pharmacy students it was important to have a no-blame culture

> *"And if you're picked up on a mistake, then you can learn about it, like I said. Like if it's dealt with in a no-blame - I don't like all the blame culture, so ... If that's dealt with properly I think you can learn a lot from that."* Pharmacy student 8

However, in Community Pharmacist 60's experience a no-blame culture had not yet developed in their area. They had recently had a PCT audit because of a DE and said that the experience of the audit had made them not want to report DEs in the future

> *"Yeah, because it is something that shouldn't really have happened, well it makes you it puts you off wanting to report things, I always do because that is what I am supposed to do code of ethics I am supposed to be truthful and honest so I do, but instead of, it seems more like a punishment when it shouldn't be."* Community pharmacist 60

This section concludes with two quotes from community pharmacist 12 about the importance of their accuracy checking procedure in preventing DEs.

> *"if I make an error I kind of go back to the checking procedure because your checking procedure is very important. And when you just made an error you are very, you know, you are on quite high alert so you are checking everything.* [when] *I haven't made an error for a while your checking procedures might be a little bit lax you might look at the script as a whole rather than each individual line and so on. You know I am being quite candid about that. Not that I am blasé or flippant, but you know everyone has seen when an error has happened. And if you are busy errors are more likely to happen, when someone is shouting at you over the counter and you have got 3 things happening, and you know you have got to get the scripts out on time otherwise people are going to get very upset. So those times you have got to go right back and actually take even more time and that can be quite difficult sometimes."* Community pharmacist 12

They then spoke about how their accuracy checking procedure that they used in the accuracy checking study (reported in chapter 4) with the one they use in their day to day practice.

> *"I was trying to work it, I was trying to do everything as completely as I normally would and that is a utopian ideal really to be able to do that all the time. If you did it in reality all the time, and you should, but you would never get any work done you know what I mean? So, but, I do try and do that all the time if I can but sometimes you can't, you don't have the time and you go back and you are about to hand it* [the dispensed item] *out to the patient and you think I am not sure I checked that properly you have to take it out and have another look at it while that patient is, just as the final check."* Community pharmacist 12

6.5. Discussion

This chapter has presented the results of an in-depth qualitative study into the MWL that CPs and pharmacy students experience in response to pharmacy pressures. It is clear from the quotes presented that there are many pressures that CPs and pharmacy students experience in their work. Many of the pressures and stressors reported in this study have been highlighted in previous studies, yet CPs continue to experience these stressors and strains in their work. For example CPs in Gidman et al's (2011; 2007) study described the "dispensing factory" and difficulties in taking breaks. In this doctoral study CPs referred to the "dispensing treadmill" and one pharmacist said that they felt that they weren't able to leave the dispensary even to take a toilet break. Breaks were felt to be important by CPs as it allowed them to take a mental break and "switch off." Research conducted by James et al (2008), also found that hospital pharmacists reported that hunger was linked to DEs as it was a distraction to the pharmacist. Some CPs in this doctoral study reported frustration as they were unable to take a lunch break till later in the day. Putting off lunch may not be advisable for CPs as hunger may also become an added internal distraction for them in their work. However, the consequence of taking a break, as many CPs reported was that it was difficult to get back "in the zone" and some felt their focus wasn't immediately 100% after a break, which for some made a break less appealing. Not being in the zone was also perceived to be linked to the occurrence of DEs and therefore CPs may feel they are in a "catch 22" situation when it comes to taking breaks.

The study by Eden et al (2009) highlighted that recently qualified pharmacists were considering leaving the profession due to the increasing target culture. All the CPs and almost all of the pharmacy students in this doctoral study spoke about the pressure to meet targets. Some targets caused more pressure than others. For pharmacy students the customer satisfaction targets were particularly frustrating as they felt it de-valued the care they were providing. This is particularly concerning as these experiences may colour pharmacy students' career or pre-registration

position choices. Targets also cause time pressure and this was one of the most significant aspects of MWL that CPs and pharmacy students experienced in community pharmacy practice. Time pressure can affect decision making and one CP quoted described how time pressures affected their decision to contact a GP about a prescription they were not sure about, weighing up whether it was worth waiting 24 hours to talk about a prescription that was within the acceptable range, but was unclear. This type of strategy frequently seen under time pressure is termed effort conservation. The individual considers "is the time and effort involved worth the predicted outcome" (e.g. that the GP will say it is all correct and fine) (Wickens, et al., 2013)? In the scenario reported by the CP in this study, the effort was not worth the predicted outcome.

The studies by Phipps et al (2009) and Gidman et al (2011; 2007) also found that CPs experienced pressure to deliver services quickly to meet patients' expectations. Identical reports were made by the CPs in this doctoral study. This was also an experience reported by the pharmacy students in this study. Pressure from patients added to the MWL of CPs and pharmacy students through increasing time pressure. The study by Phipps et al (2009) highlighted that the layout of the pharmacy contributed to CPs WL and DEs, one CP in their study reported that a messy dispensary increased the likelihood of DEs. This was reported by several pharmacy students in this doctoral study. CPs and pharmacy students in this study also reported that the layout of the pharmacy impacted on the amount of physical demand (another aspect of MWL) they experienced.

The critical incident study carried out with hospital pharmacists by James et al (2008) reported that external distractions and interruptions were related to DEs. Quotes from CPs in the study by Phipps et al (2009) also suggested that distractions and interruptions may be a safety issue for community pharmacy practice. This doctoral study found that CPs and pharmacy students felt distractions and interruptions were a safety issue. For one CP the telephone ringing became such a distraction that they

disconnected it, in order to be able to think. To carry out their work safely CPs and pharmacy staff need to be able to think clearly. One CP described the experience of their pharmacy closing at the end of the day as "my ears go quiet" which illustrates the high the level of distraction and interruptions that CPs are working under.

Frustration was a key theme throughout all the interviewee's narratives. CPs and pharmacy students reported several factors which increased their frustration levels, including (but not limited to) feeling torn between tasks or juggling tasks, being unable to take breaks, policy changes, commercial pressures (mostly targets), pharmacy funding, co-workers, lines of communication with prescribers and lack of control over WL and services offered. Frustration is an aspect of MWL and therefore high levels of frustration will be contributing to CPs and pharmacy students overall perceptions of MWL. MWL was found to be related to pharmacy student's detection of DEs and so interventions to reduce the frustration associated with the role and tasks may help novice pharmacists improve safety of their work.

Perhaps the most concerning pressures reported were by the CPs who were pharmacy managers. For one CP the strain of combining these two important roles was too much and they were seeking alternative employment. The impact of combining both these roles on the wellbeing of CPs and the safety of their work has not been considered in the WL literature to date.

Several CPs and pharmacy students spoke about the times when they had little control over their WL, for example spikes in the busyness of the pharmacy each day. Other CPs talked about the lack of control they had with regard to running their pharmacy or new pharmacies opening in the local area and becoming competition. The consequence of lack of control over their WL and the pressures that came with spikes in WL in the pharmacy, led one CP to activate the fire alarm, so that patients would have to exit the pharmacy allowing this CP to gain a few minutes peace of

mind. WL control has been found by previous research to be related to the level of mental fatigue experienced. When individuals have high levels of control over the management of their WL their mental fatigue levels are lower when compared to individuals who have no control over their WL (Hockey & Earle, 2006). This effect on mental fatigue was explained by Hockey and Earle (2006) to occur through depletion of executive control function capacity (one aspect of WM) when individuals had little control over their WL. When individuals had full control of their WL, they were able to allocate resources flexibly which meant that executive function capacity did not deplete as significantly (Hockey & Earle, 2006). In this doctoral study one of the main coping strategies CPs and pharmacy students reported using was planning their WL as much as possible "to put some control back into the system." This strategy would allow them to reduce the burden on limited executive function.

6.6. Summary of the chapter

Many of the reports from participants in this study concur with reports made by CPs in other qualitative studies carried out in other parts of the UK. The level of agreement between studies illustrates that these pressures are not experienced by the few CPs who take part in these studies. In fact they are experiences which are common to many CPs around the country. This study is the first to consider and discuss with CPs the impact these pressures and stressors may be having on perceptions of MWL and their narratives clearly indicate the role that pharmacy pressures play in exacerbating their perceptions of MWL. CPs in this study described their experiences of MWL as something that was "in the back of my head" and mental overload was associated with feeling like "the cogs break up" and "just an overload in my head with it all sectioned up." In the next chapter the findings from this qualitative study are drawn together with the findings from the MWL diary and the accuracy checking experiments.

CHAPTER 7: DISCUSSION

"..so if you feel as though there are too many prescriptions to label, or there are a lot of prescriptions in your pile which you are supposed to be clinically checking - so that the accredited checking technician can check do the final check with the prescription. Then you must say 'umm can someone take some of these, I don't think I am going to have time to finish all this.' Instead of trying to not give it your full attention. So that is what we do. And on days when we haven't got the accredited checking technician, I say to the dispenser 'please can you look through the prescriptions and see all the items of the prescription that we can dispense, and put away, and get done, and we'll do those now, and then I will clinically check the rest of the prescriptions, while you are doing that?' So that we have reduced the workload for the next day, and sort of just being aware of how you can plan you workload and reduce the stress level."

Community Pharmacist 41

7.1. Chapter Outline

This thesis has presented the findings of a mixed methods study into the impact of mental workload (MWL) on community pharmacists' (CPs') and pharmacy students' ability to detect dispensing errors (DEs) when carrying out a final accuracy check. Three studies were undertaken, and have been discussed individually in the preceding chapters. In this chapter the findings of the three studies are triangulated to provide a greater insight into the impact of MWL on CPs and pharmacy students work performance. The discussion of the results is organised around the conceptual framework for this research, which was the Cognitive Systems Model (CSM; Grasha, 2001b; 1996; Grasha & Schell, 2001). The model is presented and outlined again and then the results of this doctoral research that relate to each aspect of the CSM are considered in turn. This allows for a natural structure to combine both the quantitative and qualitative findings. Throughout the chapter, the findings are linked to the occurrence of DEs and therefore the impact these findings may have on patient safety. Before concluding this chapter includes a brief discussion of the job characteristics model (JCM; Hackman & Oldham, 1976) and the principles of job design and how the findings of this doctoral research may provide impetus to consider the redesign of how CPs carry out their work (whilst retaining their current role). This chapter concludes with the strengths and limitations of this doctoral research and future research directions.

7.2. The Cognitive Systems Model

The CSM (See Figure 7.1 below) demonstrates how human information processing (the cognitive systems) and subsequent task or work performance are adversely or favourably affected by a variety of given psychosocial factors. The psychosocial factors specified in the CSM include the subjective and objective features of the task (e.g. task complexity, time pressure and time allotted to complete the task), the characteristics of the person carrying out the task (e.g. age, gender, personality traits), interpersonal relationships (e.g. at work and outside of work), organisational characteristics (e.g. organisational roles and norms,

supervisory practices), extra-organisational influences (e.g. interfaces with boards of pharmacy, governmental and commercial pressures on pharmacy) and the physical environment (e.g. levels of illumination and noise) (Grasha, 2001b). The underlying assumption of the CSM is that interaction of psychosocial factors with the task and cognitive system can produce tension and stress which may reduce the effectiveness of cognitive processes and therefore increase the likelihood of errors being made. In this model, MWL is seen as a subjective component of the interplay of task and environmental elements on cognitive system performance (Grasha, 2002b).
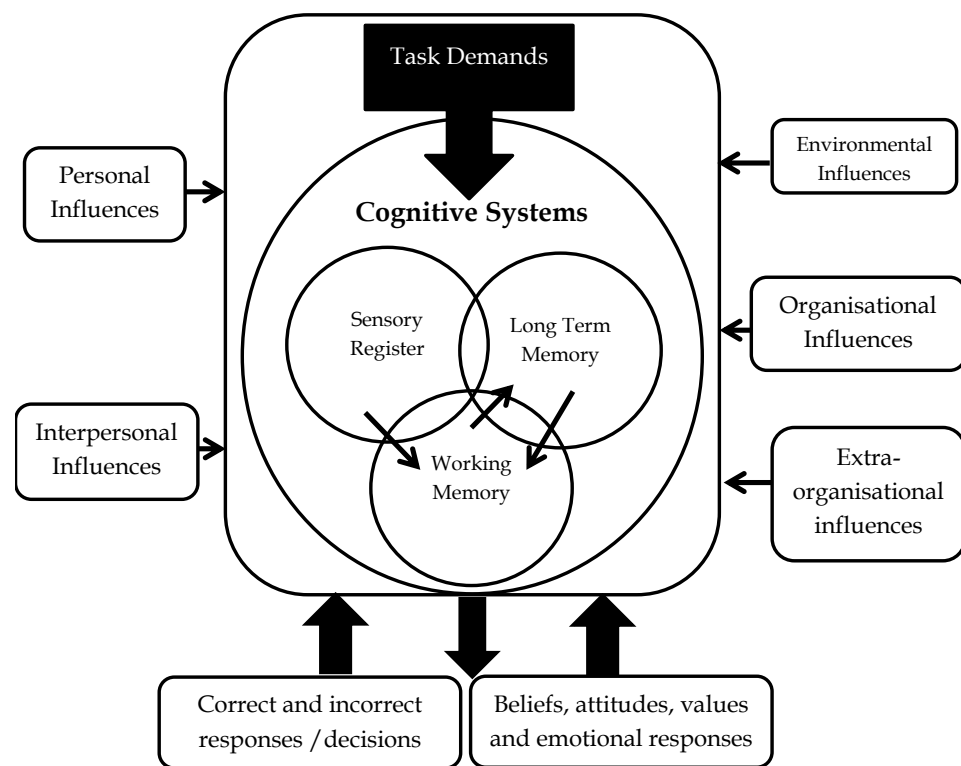
Figure 7.1: The Cognitive Systems Model (adapted from Grasha, 2001b)

7.3. Findings related to the models of cognition and human error

This doctoral research was not designed to test models of cognition or human error. However, experiences reported in the interviews, on the

MWL diaries and findings from the experimental research may be explained in the context of these theories. For example, accuracy checking experiment 1 (reported in chapter 4) found that CPs and pharmacy students significantly differed in their performance on the accuracy checking task and the types of DEs they detected. CPs were more likely to miss labelling errors whereas pharmacy students missed both labelling and content errors with equal frequency. As pharmacy students are still training to be pharmacists, it would be expected that CPs would outperform pharmacy students on this task. However, the qualitative study reported in chapter 6 provided insights into why pharmacy students thought they made or missed DEs. For most students it was lack of knowledge about the different versions of the same medicine, so they picked the wrong form as they did not know there was an alternative formulation. For other students, simply being presented with a new medicine disrupted their successful implementation of knowledge and procedures for checking and dispensing that they had previously gained. One student referred to this as "missing the basics" as when they saw a new medicine they forgot aspects of the checking and dispensing procedures they had learnt. Based on models of human information processing and human error, it is likely that these pharmacy students are still working between the knowledge and rule-based levels of Rasmussen's framework. A slip in the pharmacy students' checking and dispensing process may therefore occur when they encounter a new medicine because they have insufficient attentional and WM resources to be able to monitor whether their implementation of their mental sub-routine for "how to check a dispensed medicine" has been carried out successfully. This would lead to stages in this process being missed (Rasmussen, 1982, 1983). If a pharmacy student was carrying out this work in a distracting and interrupting environment, their attentional resources may be reduced further, making an action slip more likely.

The experimental studies also provided some evidence for the demands that distractions and interruptions may make on CPs and pharmacy

students mental resources whilst carrying out an accuracy checking task. CPs and pharmacy students who were distracted whilst accuracy checking reported significantly higher MWL than the low WM group who were not distracted. This finding suggests that distractions and interruptions make demands of the limited mental resources available. This, in turn reduces the resource available to carry out an accuracy checking task. In the experimental study this did not lead to a reduction in DE detection. However, all the CPs and many of the pharmacy students in the qualitative study spoke about needing to be "in the zone." This term was used by interview participants to refer to the high level of attentional focus required to carry out their work successfully. High MWL in real-life practice could lead to a reduction in mental resources available to the executive control function of WM which is the most likely process that would enable CPs to be in the zone. CPs reported in the interviews that they found it hard to get into the zone in the mornings and after breaks from work, and so some CPs avoided doing safety critical tasks (e.g. methadone preparation) at such times or when pressures were high. Data from the MWL diaries suggested that this was an issue for many CPs as the averaged MWL diary data showed a peak in performance concern first thing in the morning. The interview data highlighted that this performance concern was due to CPs not being able to get in the zone as soon as they arrived at the pharmacy.

These findings indicate the high level of attentional focus that CPs and pharmacy students feel they need to carry out their work safely. Section 7.9 in this chapter explores the impact of interruptions and distractions in the environment and other factors in the environment that can affect CPs attentional focus. The next section explores the findings of this research in relation to task characteristics.

7.4. Pharmacy task characteristics

According to the CSM the characteristics of a task include its objective features (e.g. the complexity of the prescription being checked) and

subjective features (e.g. perceived time pressure). These features interact with cognitive systems to make a DE more or less likely.

In experiment 1 the participants were asked to accuracy check a set of dispensed items, whilst at the same time remembering a list of 6 two-digit numbers, or just 1 two-digit number. Participants who had the list of 6 two-digit numbers to remember reported significantly more task frustration (on the NASA-TLX scale) compared to the participants who only had to remember 1 two-digit number. By adding a simple number memory task to the accuracy checking task it increased task frustration. In the qualitative interviews CPs talked about holding lists of things they needed to do that day in their head. This would be similar to holding a list of numbers in their head during the accuracy checking task. Holding a list of things to do will require WM capacity, and if those tasks are not being ticked off they will serve as a reminder of goals that are not being met.

During the interviews CPs and pharmacy students reported several task frustrations and one of these frustrations was not being able to tick off of things on their to-do lists. Another task frustration for CPs was juggling tasks and having too many competing priorities. However, the interviews also revealed that when CPs were ticking things off their to-do lists this led to frustration for other members of staff. It is therefore not surprising that when MWL diary ratings were compared to the ratings obtained in experiment 1 and 2 a significant difference in frustration scores was found. Frustration ratings were reported to be significantly higher when CPs were working in their pharmacies compared to the accuracy checking experiments. It may be that this difference is related to CPs not having a list of other things they had to do in that setting.

Another task characteristic that CPs and pharmacy students spoke about in the interviews was time pressure. Both groups of participants felt time pressure reduced the safety of their work. It was also found that the time pressure reported by CPs in experiments 1 and 2 and on their MWL diaries did not significantly differ, suggesting that the time pressure simulated in

the experiments closely resembled the time pressure experienced in practice. This is important because research carried out by Reilley et al (2002) found that the amount of time participants had to carry out an accuracy check affected the type of DEs missed. When participants were asked to check 120 items in 120 minutes they missed significantly more labelling errors compared to participants who were asked to check 72 dispensed items in 120 minutes. The participants in this study were undergraduate psychologists so the checking task did not employ realistic prescriptions, or real medicines However, it is interesting that the condition which allowed a minute per item, which is equivalent to the amount of time that was provided in this doctoral research, led to significantly more labelling errors being missed. The time given to participants to check the items in this doctoral research was based on pilot study findings of how long participants took on average to complete the task. Further research is required to identify whether CPs, like the participants in Reilley et al's study (2002), would miss fewer labelling errors if they were given more time to check the dispensed items.

There was also some suggestion in the qualitative data that CPs decisions were affected by the amount of time pressure they were under. For example one CP reported that they would not query a prescription that they were unsure about, with a prescriber if it was within the realms of legal or safe prescribing. This was because the CP often experienced difficulties getting in touch with prescribers (usually GPs) and it was likely to transpire that the prescription was correct despite the CP's uncertainty. This type of strategy frequently seen under time pressure is referred to by Wickens et al (2013) effort conservation. The CP weighs up whether the time and effort involved is worth the predicted outcome (e.g. that it is a false alarm – the prescriber will say the prescription is correct). By taking this approach CPs are less likely to make false alarms which are costly in time and effort. However this more conservative strategy may increase the likelihood of missing a DE or prescription error when they do occur (Oliver, Bjoertomt, Greenwood, & Rothwell, 2008; Wolfe et al., 2007). One

strategy to improve detection of infrequent targets like DEs or prescription errors is to encourage CPs to report more false alarms. However the time pressures experienced in community pharmacy may mean that this technique may not be appropriate (Oliver, et al., 2008; Schell, Hunsaker, & Kelley, 2006; Wolfe, et al., 2007).

Using the data from experiments 1 and 2 it was found that the CPs and pharmacy students who detected all the DEs in the accuracy checking task had a more liberal response criterion. This meant that they were more likely to report false alarms. This may provide an explanation why CPs missed labelling DEs, because all participants reported some time pressure meaning that they may have made a decision that checking all aspects of the dispensing label was too effortful under the time constraints of the study. However, it may also be that medicine packaging provides a lot more information that would signal that an error has been made due to the variation in colour of the packaging and the weight of the product. The dispensing labels on medicines are more uniform and so this may make content errors much easier to detect (a stronger signal) compared to labelling errors.

An observer's perceptual sensitivity can also be affected by time pressure (Wickens, et al., 2013). It was found that CPs and pharmacy students who detected all the DEs not only had a more liberal response criterion, they also had higher perceptual sensitivity scores (d' values). There are several techniques some of which could be employed in pharmacy practice that can change an observer's perceptual sensitivity to the target stimulus. For example providing frequent rest breaks from a task, providing feedback on the results of the task and slowing down the rate of item presentation (Wickens, et al., 2004). It may be that pharmacists are intuitively using these techniques already. For example one CP in the interview study spoke about feeling the need to slow down when they felt they were under high MWL or time pressure.

7.5. Individual difference factors

7.5.1. Pharmacy expertise

This doctoral research was particularly interested in one individual difference factor, pharmacy expertise, and its effect on detection of DEs and reports of MWL. This had been one factor, that previous research into accuracy checking performance, was unable to account for in their study design (Grasha, Reilley, Schell, & Tranum, 2001; Reilley, et al., 2003; Schell, et al., 2006; Schell & Reilley, 2004; Schell, et al., 2005). Several differences were found between CPs and pharmacy students in their reports of MWL and performance on the accuracy checking tasks. There were also noticeable differences in their narratives in the qualitative study.

A significant difference was found between CPs and pharmacy students in their reports of MWL in experiment 1. As predicted pharmacy students reported higher levels of MWL compared to CPs. This would be expected as pharmacy students are less practised at the task of accuracy checking. They also have less experience of the range of medicines used in the study so they would have needed to rely on their WM resources more than the CPs. Pharmacy students in experiment 1 also missed significantly more DEs than CPs. MWL levels were also related to pharmacy students' detection of DEs, but not CPs error detection. Pharmacy students (from experiments 1 and 2) who reported MWL levels of 5.33 or higher (out of a total of 10) were more likely to miss DEs than students who reported MWL levels lower than 5.33. This finding suggests that only pharmacy students (or novice pharmacists) experience sufficient MWL to impair their performance. However, it may be that the accuracy checking task was not complex enough to measure whether MWL impairs CPs (expert pharmacists) accuracy at detecting DEs. This finding shows that it cannot be assumed that pharmacy students and newly qualified pharmacists are able to carry out their work safely under the same WL and environmental stressors that CPs can.

The qualitative interview study also found that CPs and pharmacy students reported experiencing different pressures when working in community pharmacies. For example several students reported stress and frustration in reaction to messy dispensaries but CPs did not. CPs who took part in the interviews, reported other stressors and strains, for example several CPs talked about the pressure related to combining the pharmacist and pharmacy manager roles. One reason for the different frustrations and pressures experienced by CPs and pharmacy students is that they are taking on different roles, as pharmacy students are not qualified to take on all the responsibilities that CPs do. However, this difference further illustrates the importance of taking an individual approach when considering what factors might be increasing an employee's MWL or stress levels.

Other important differences were observed between CPs and pharmacy students' performance on the accuracy checking task. When performance was compared between task 1 and task 2, pharmacy students were found to improve in their detection of DEs but CPs' detection accuracy declined between the two tasks. For the pharmacy students, overall MWL, time pressure, performance concern and task frustration decreased between tasks 1 and 2. Significant negative correlations were found between error detection and three of these variables (overall MWL, time pressure and performance concern). It was therefore suggested that pharmacy student's performance improved due to the reduction in MWL they experienced. These same variables were not correlated with CPs performance. However, the reduction in CPs' error detection over time may be linked to a significant shift in participants' decision criterion that was observed as the study progressed. CP's decision criterion moved from a liberal setting to a more conservative position. Schell and Cox-Fuenzalida (2005) and Bilsing-Palacio and Schell (2003) also found a similar criterion shift when they asked undergraduate psychology students to undertake a simulated accuracy checking task. Bilsing-Palacio and Schell (2003) suggested a change in criterion would be expected because as participants carry out the

task they will be dynamically forming impressions about the task and re-evaluating these every time they come across an error or error-free item. This also relates to the feedback loop shown in Figure 2.2 in Chapter 2 which highlights how humans continually monitor and analyse their performance on a task. It is likely that in this study CPs were expecting to see a higher rate of DEs when they first started the task. Then as the task progressed and they were not detecting as many DEs as they had expected they altered their response criterion to fit with their evaluation of the prevalence of the DEs. In community pharmacy practice a similar criterion shift may occur over time as a CP gets used to the other members of the pharmacy team and the DEs that are commonly made by them and other members of the team. One quote from the qualitative data also described their experience of changing their response criterion to a more conservative position following the detection of a DE. This criterion shift was short-lived, because after a while, when no more DEs had been detected they adopted a more relaxed approach to their accuracy checking and became less vigilant.

An alternative explanation of the criterion shift observed in the CP group between tasks 1 and 2 is that it is related to a decline in temporal demand (time pressure). In the interviews CPs talked about needing to be "in the zone," and it may be that the task was too straightforward and repetitive that once the novelty of carrying out the task in this experiment wore off, they became less engaged in the task. Changes in subjective states observed in the CP data suggested that decreased task engagement may have occurred. The consequence of decreased task engagement may be a reduction in attentional focus (no longer being in the zone), which in turn may have led to a reduced detection of DEs. This is a tentative explanation as levels of attention were not measured in this study.

7.5.2. Other individual difference factors

The MWL diary study found that there was a difference in MWL scores between CPs who worked full-time and CPs who worked part-time. This

difference could have occurred for several reasons. For example CPs who worked part-time may have shorter shifts than CPs who worked full-time. Part-time CPs may also take on different roles to some of the full-time CPs. For example some CPs in the MWL diary and qualitative study who worked full-time were pharmacy managers. Part-time CPs may not take on the additional role of pharmacy manager. The data collected in the MWL diary study cannot explain why this may be and no insights were provided on this issue in the qualitative data. This finding could be explored further in future research.

The accuracy checking studies also highlighted other individual difference factors which may be of importance. For example, when CPs and pharmacy students who detected all the DEs were compared to those who had not, a significant difference was found in participants' scores on the conscientiousness personality trait subscale. Schell and Reilley (2004) also found that higher levels of trait conscientiousness and trait extroversion were related to superior performance at accuracy checking. Therefore conscientiousness may predict performance on this task. However, it should be noted that this trait may not favour other aspects of the dispensing process.

7.6. Interpersonal influences

It was highlighted in the previous section that trait conscientiousness was related to detection of all the DEs in the accuracy checking study. In the qualitative study the impact of the perceived conscientiousness of pharmacy colleagues was discussed by several CPs and pharmacy students. From the CPs perspective this was often in relation to trying to find ways to motivate underperforming staff. Pharmacy students' had a different perspective. Some students reported carrying the WL of other members of the pharmacy team who were not as passionate, interested or willing to work as hard as they were. Hackman and Oldham's (1976) JCM suggests that people's motivation to carry out a job can vary depending on their level of skill and knowledge for that job, in their levels of growth-

need-strength (individual needs for accomplishment, development and learning in the future) and satisfaction with the work context. When pharmacy students work as dispensing technicians or as trainee pharmacists, they may feel differently about the role they are undertaking compared to permanent members of staff who are doing the same job but not training to be a pharmacist. For example pharmacy students may have different, knowledge and skills (gained through their university studies) compared to other members of the pharmacy team. The pharmacy students' knowledge and skills in pharmacy practice may increase their motivation in this role. Pharmacy students are also studying at university which other members of the pharmacy team may not be, and for this reason pharmacy students may also have higher levels of growth-need-strength. Pharmacy students may also be more satisfied with the work context than their colleagues as they feel in the future they will be able to take on the role of the pharmacist and so whilst they are working they are also developing more skills to help them achieve this goal. Therefore there are several reasons why pharmacy students may be more motivated in this working environment than other colleagues. These differences in motivation are important as pharmacy students reported that this was a source of frustration, and therefore a factor which increased their MWL levels. Pharmacy students' accuracy checking performance was affected by MWL levels therefore interpersonal factors may affect patient safety.

7.7. Organisational influences

The qualitative study identified several organisational influences that were affecting CPs and pharmacy students' MWL. One of the main stressors reported by both groups was understaffing and staff turnover. Understaffing left high WL for other members of staff, but it also meant that pharmacies were not able to provide cover if members of staff wanted to undertake training and that breaks were difficult for CPs to take. The interview study undertaken by Gidman et al (2011; 2007) found that well trained pharmacy support staff were key in CPs perspectives in managing the high WL. This finding was supported by qualitative findings from this

doctoral research. Students and CPs in this doctoral study also felt that high WLs were leading to increased pharmacy turnover. This was a finding that Eden et al (2009) also reported following their interviews with recently qualified pharmacists who were intending to leave the profession.

CPs and pharmacy students who took part in the interviews in this doctoral research also reported high levels of frustration and MWL which were related to feelings of low control over their WL. This was due to the unpredictable nature of the walk-in patient WL, commercial targets, and for some, lack of autonomy in deciding which services to offer in their pharmacy. This lack of control was also related to the task frustration that CPs spoke about in the interviews and may also be related to the task frustration scores on the MWL diaries. The MWL diaries showed that there were two times where community pharmacies were (on average) at their busiest. These times were 11 o'clock in the morning and five o'clock in the afternoon. One pharmacist described themselves as feeling "over a barrel" at these times as they had no control over what work would be completed during the busy times in their pharmacy.

Previous experimental research has shown that times when the volume of work shifts from high to low are related to an increase in DEs (Grasha, 2001a). Control over WL is therefore important to the occurrence of DEs. It was also suggested in Chapter 6 that low levels of control over the pharmacy WL may lead to quicker depletion of executive function (an aspect of WM) resources, and to higher rates of subjective fatigue (Hockey & Earle, 2006) which would serve to increase perceptions of MWL. The qualitative data revealed that one way CPs had found to manage their unpredictable WL was to plan and organise the portion of work that was predictable. This strategy may allow CPs to protect executive function resources, although only at times that they feel they are able to plan their WL.

Within the occupational psychology literature two models are of particular note in relation to the level of control CPs have over their work. The first is

the Demand-Control Model proposed by Karasek (1979). This model suggests that job strain is caused by low job control and high work demands (which includes work overload and time pressure). Karasek (1979) suggested the level of control an employee has over their WL determines the level of job strain they experience. The less control employees have over their work the more strain they experience. This model has also been used to predict pharmacy safety climate in UK community pharmacies (Phipps, Malley, & Ashcroft, 2012). In the study by Phipps et al (2012) CPs who reported low control over their work and high demands also rated their organisation as less willing to develop and maintain safety (poor organisational learning). The second model is the JCM (Hackman & Oldham, 1976) which links autonomy and control over work to job satisfaction and motivation. Low autonomy and control over work is related to low levels of motivation (Hackman & Oldham, 1980).

7.8. Extra-organisational influences

Extra-organisational influences identified in the CSM include interfaces with boards of pharmacy, governmental and commercial pressures on community pharmacies. One factor that has affected the pressures experienced by CPs in the UK are levels of funding from the government for pharmacy services. The new contractual frameworks (discussed in Chapter 1) altered the payment structure for community pharmacy work. The reimbursement for traditional dispensing activities was reduced and the funding that was saved through these reductions was made available for the payment of new clinical services that CPs could undertake. However, a limit was set on the number of clinical services that CPs could be paid for providing. For example a limit of 400 MURs was set for each community pharmacy in the drug tariff (Pharmaceutical Services Negotiating Committee, 2013). If CPs carry out more than 400 MURs they will not be paid for this service. These changes to the pharmacy contracts in 2005 meant that community pharmacies had to change their strategy in order to earn the same income from NHS services as they had in previous years. For large pharmacy chains this would be important due to

commitments to shareholders. The alteration in how community pharmacies are now funded, and the cap on how many MURs (and other enhanced and advanced services) community pharmacies can be paid for may be one reason why the targets have become such a big emphasis in many community pharmacy organisations. This emphasis is important to consider because the qualitative data showed that CPs and pharmacy students in this study reported significant pressures and frustrations in relation to these targets. Individuals who commission UK community pharmacy services at a national level can therefore have a large impact on the workplace pressures that CPs and their team's experience.

One of the key findings from the accuracy checking studies was that only 35% of the CPs and 25% of the pharmacy students detected all the DEs in the study. This suggests that accuracy checking is not a task that humans can carry out with 100% accuracy. For community pharmacy practice this is important because under section 64 of the Medicines Act 1968, the responsible pharmacist can be criminally prosecuted (without evidence of intent to cause harm) for a DE that they or a member of their team makes (CPS, 2013; HM Government, 1968). This means that they could be prosecuted if they or a member of their team missed a DE through accuracy checking. If only one third of CPs are able to carry this task out with 100% success, this suggests that missing a DE may be outside of the CPs control and therefore a CP could be prosecuted for a DE that was unavoidable to them. Factors such as these should be taken into account when designing pharmacy tasks, but also are important for the regulatory and professional bodies to be aware of.

For some CPs in the qualitative study, particularly locum pharmacists the responsible pharmacist regulations were a cause for concern and a source of strain. This was because locums felt they couldn't delegate as much work as they would like because they didn't know the competency of the team they were working with. Other CPs felt that these regulations had

confused personal with corporate responsibility. As CPs are reporting high levels of WL pressure it could be suggested that they shouldn't have to take responsibility for DEs made during times of high WL pressures, as these pressures are often imposed by government and organisational targets. Although some pressures CPs and pharmacy students experienced were driven by their own professional standards or patients.

Another extra-organisational factor that CPs and pharmacy students spoke about during their interviews was the perceived lack of integration between community pharmacy and other health services in the local community. Many felt improved lines of communication between CPs and general practitioners would reduce the WL pressures for CPs and their teams and reduce levels of frustration. A study by Hughes and McCann (2003) suggested that one of the barriers to communication was the GPs perception of CPs as shop-keepers. CPs in the qualitative study felt that GPs (the general public and the government) still hold this view about them and this led to significant frustrations for CPs. A scenario was described by a CP during the qualitative interviews (which is also discussed in section 7.4 above) where a CP was reluctant to contact a GP about a query they had about a prescription. This was because they felt it would take too long to get hold of the GP. The CP thought the prescription was within the realms of legal and safe prescribing and so was probably correct, but the CP was uncertain if this was the case. This scenario demonstrates the impact that poor lines of communication between GPs and CPs could have on patient safety. Therefore this is an issue that could be tackled to improve patient safety. As the new clinical commissioning groups, which are run by GPs are now responsible for the commissioning of primary care services, this would seem an ideal time for community pharmacies and the pharmacy profession to build stronger networks with GPs (News Team, 2013).

7.9. The pharmacy environment

The physical environment of the community pharmacy can also affect CPs cognitive processes (Grasha, 2001b). Previous research has suggested that noise levels, lighting, interruptions and distractions and the physical layout of the pharmacy may have an impact on CPs and their teams (Burford, Yeck, Tucker, Barker, & Pasupathy, 2011; Chui, Mott, & Rodriguez, 2011; Flynn et al., 1999; Flynn et al., 1996; James et al., 2009; Reilley, et al., 2003). One aim of this doctoral research was to explore the impact of distractions and interruptions on CPs' and pharmacy students' performance at accuracy checking and their MWL. Experiment 2 tested these relationships and no significant effect was found on CPs' and pharmacy students' overall MWL and accuracy checking performance when they were distracted and interrupted. However, CPs and pharmacy students in the distraction group did report significantly higher levels of task frustration compared to those who were in the low WM group (of experiment 1) but not the no distraction group (of experiment 2). This suggests there may be an impact of distractions and interruptions on task frustration, but further research is needed to confirm this finding.

The qualitative data suggested that CPs and pharmacy students felt distractions and interruptions were a significant issue in community pharmacy. For example, one CP spoke about having to disconnect the phone at times to be able to concentrate on their work. Others reported the perception that distractions and interruptions were linked to DEs. Other qualitative research has also suggested that distractions and interruptions contribute to DEs (James, Barlow, Hiom, & Whittlesea, 2008). It may be that the distractions and interruptions simulated in experiment 2 were too conservative to affect CPs and pharmacy students' performance and MWL. Or it may be that interruptions and distractions do not have an effect on accuracy checking. The survey carried out by Chui et al (2011) suggested that CPs working in pharmacies in the USA perceived only the clinical and the legal checks to be affected by interruptions and distractions. This

survey also suggested that CPs felt that accuracy checking performance was affected by time pressure.

A study carried out in the USA, looked at the impact of a distraction free community pharmacy, modelled on the "sterile cockpit rule" used in aviation (LePorte, Ventresca, & Crumb, 2009). The sterile cockpit rule states that no non-essential tasks will be undertaken during high risk times of flight (e.g. take-off and landing). Non-essential tasks include communicating with passengers during take-off and landing, communication with other members of flight staff about matters unrelated to the procedure currently being undertaken, eating in the cockpit and reading non-essential information at that time (Electronic Code of Federal Regulations, 2013). It is harder to implement a sterile cockpit in community pharmacy as there will always be safety critical work being carried out by one member of staff so it may not be feasible to prohibit non-essential communication. To create a sterile environment LePorte et al (2009) created verification zones. These were clearly demarcated areas where CPs would check prescriptions and other members of staff were informed not to disturb them when they were in these zones. They also gave dispensing staff cards, so that dispensing staff could triage telephone calls and walk-in patients. When a CP was needed on the phone or for a consultation, the dispensing staff would place a card by the CP. The CP would then know that when they finished checking a prescription, there would be someone waiting to talk to them. This prevented any verbal distraction and also meant that no immediate response was required from the CP. This intervention led to a small but significant reduction in DE rates LePorte et al (2009). A similar model may also be of use to community pharmacy practice in the UK. However, CPs reported in the qualitative part of this doctoral research that the telephone ringing was a distraction in itself. It may therefore also be important to remove the telephone from the dispensary to support a sterile environment.

7.10. Redesigning the community pharmacists' work

At the beginning of this chapter it was proposed that the work that CPs undertake could be redesigned in order to reduce the impact of WL pressures on CPs and other members of the pharmacy team. This would not require changing the role, but perhaps some of the factors that control CPs WL at the moment. Hackman and Oldham's (1976) JCM has been used in many settings to redesign jobs, in particular to guide ways in which job enrichment can be undertaken to improve employee outcomes, e.g. job satisfaction and organisational outcomes e.g. reduced turnover (Oldham & Hackman, 2005). The model is presented in Figure 7.2 below.

This model is particularly useful for community pharmacy practice because the enhanced and advanced clinical services that CPs are now able to provide could be considered as work enrichment. In the qualitative interviews several CPs used the term "dispensing treadmill" to describe their work. This was because the dispensing activity is non-stop and often CPs felt that they could spend the whole day doing that and nothing else. This description highlights that sometimes CPs work may lack variety. Pharmacy students and CPs both talked about the difficulty to maintain concentration or stay "in the zone" when the tasks they were doing were highly repetitive, so task variety in a community pharmacy setting also has some safety implications.

The aim of the new contractual frameworks was to provide CPs opportunities to move away from the dispensing activities in order to undertake enhanced and advanced clinical services for the benefit of community pharmacy practice and patient care. However, due to the way enhanced and advanced services are funded (discussed in section 7.8 above and Chapter 1) a target culture in community pharmacy has developed. CPs report these targets are a significant frustration for them in their day to day work because they feel they have lost professional autonomy over when these services should be delivered. Autonomy as

discussed previously is important for job satisfaction, but also in minimising the demands that work make on our limited mental resources. Autonomy would allow CPs the freedom to undertake tasks when they feel they have sufficient mental (and other – e.g. staffing) resources to do so (Hockey & Earle, 2006).
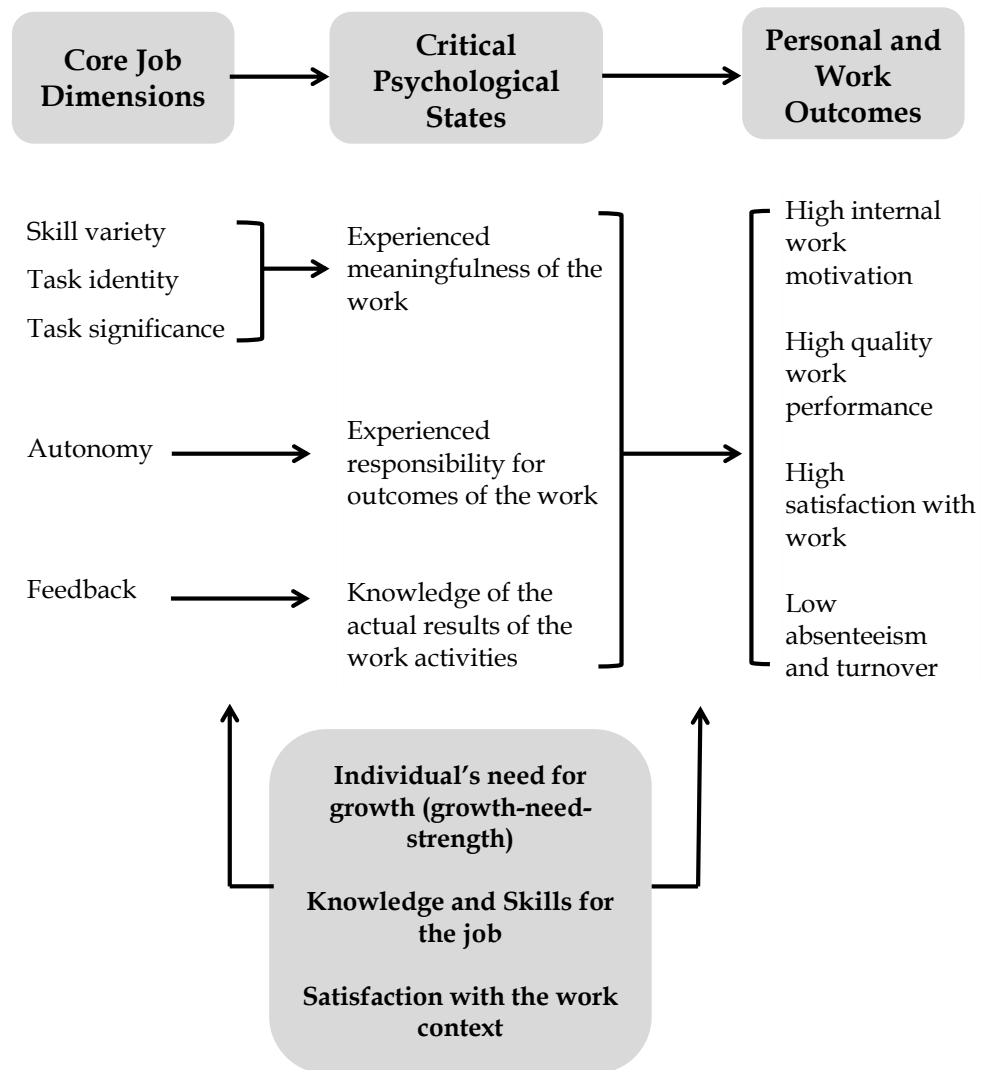
Figure 7.2. The Job Characteristics Model (From Hackman & Oldham, 1980, p.90, with permission)

CPs also experience frustration and pressure because undertaking an advanced and enhanced service leads to prescriptions accumulating whilst they are in an advanced or enhanced service consultation with a patient. Prescriptions accumulate because the current pharmacy regulations

(Health Act (2006) and Medicines (responsible pharmacist) Regulations (2008); HM Government, 2006, 2008) mean that the CP has to be present for the sale of P (pharmacy) and supply of POM (prescription only) medicines. CPs are also legally required to carry out a clinical check of a prescription to ensure it is safe and correct (RPS Support, 2011). These regulations mean that pharmacies which only have one CP cannot carry out many core functions (including the dispensing of P and POM medicines) whilst the pharmacist is on a break, or conducting an enhanced or advanced service (Bradley, Schafheutle, Willis, & Noyce, 2013).

Changes to the supervision regulations have been proposed to support CPs in providing enhanced and advanced services by allowing for some medicines to be dispensed by pharmacy support staff without a CP being physically present. However a recent study found that CPs were unwilling to relinquish this control and pharmacy support staff were concerned about taking on that responsibility (Bradley, et al., 2013).

In the qualitative interviews carried out for this doctoral research CPs reported job satisfaction from undertaking enhanced and advanced services. Therefore these services are meaningful for the CPs. However, it seems likely that without changes to the supervision laws that CPs WL, MWL and task frustration will continue to increase as they try to provide the advanced and enhanced services whilst at the same time overseeing the dispensing activity.

7.11. Strengths and limitations of this research

7.11.1. Strengths of the experimental research

This the first study with UK pharmacists and pharmacy students to experimentally measure the relationship between MWL and DEs. By carrying out DE research under controlled conditions it allows for the measurement of the relationship between variables like MWL with DEs as confounding variables can be controlled or accounted for. The benefit of the experimental approach is, as Grasha (2002a) highlighted that it allows the researcher to move beyond personal reflections on DEs in pharmacies

and measure what happens for a group of people who encounter the same factor in their workplace. This experimental approach also does not rely on the self-report of DEs which allows the quantification of DEs that CPs and pharmacy students are unable to report.

Taking an experimental approach also allowed novice and expert pharmacists' accuracy at detecting DEs and their MWL during the checking tasks to be compared. Some important differences have been highlighted by this research in how CPs and pharmacy students respond to WL demands. These differences mean that future research should not use a sample of pharmacy students for research which is designed to generalise to pharmacists' practice. CP participants were also strategically recruited for the experimental research using criteria based on published literature on the demographic characteristics of CPs working in the UK. This ensured a representative sample of CPs was recruited for this research. However, this was not possible for the pharmacy student participants as there were a limited number of pharmacy students who could be recruited for this research.

7.11.2. Limitations of the experimental research

The main limitation of the experimental research is that it focussed on one aspect of the dispensing process. This was important as different stages of the dispensing process will rely to a greater or lesser extent on WM and attentional resources and therefore stressors could affect each stage of the dispensing process differently. This means that the findings of the experimental research can only be generalised to the accuracy checking stage. The accuracy checking task was also less complicated than it may be in real life as all the prescriptions in the task were single item prescriptions. Prescriptions can have multiple medicine orders on, which will therefore involve a more complex accuracy checking process.

The measures of MWL, other mood states and personality that were used were all self-report measures. The benefit of using a self-report measure was its ease of use, which meant measures of MWL could be taken under

experimental conditions, a number of CPs were also able to rate their MWL during a shift in their pharmacy. However, using a self-report measure means that social-desirability and demand characteristics may add an element of noise and bias to the data. It is also not a continuous measure of MWL, so it cannot capture fluctuations in MWL as the task is carried out. This measure also relies on information which the CP or pharmacy student can consciously report. Despite these issues, the measure used, the NASA-TLX is the most widely used self-report measure of MWL. It is also able to measure aspects of MWL which other techniques cannot. For example, the NASA-TLX can identify whether temporal demand or physical demand is causing more MWL for the CP which other more detailed techniques (e.g. electroencephalogram) cannot (Hockey, 2002; Wickens, et al., 2013).

In experiments 1 and 2 CPs missed more labelling DEs than content DEs. However the data collected could not be used to identify whether CPs missed labelling errors because they failed to check all aspects of the label against the prescription (failure to look), or they checked all aspects of the label against the prescription but misperceived the information they saw (failure to see). Previous research suggests that labelling errors are missed more often under time pressure, and as time pressure was kept constant for all conditions of this research it is not known whether this affected the detection of labelling errors.

Previous research has shown that CPs and pharmacy students can vary (to some extent) in the accuracy checking procedure that they follow (James, Davies, Kinchin, Patel, & Whittlesea, 2010). The procedure that the CP and pharmacy student participants used to carry out the accuracy check was not measured in this study so it is not known whether differences in the procedure used contributed to DEs.

The physical demand reported by CPs on the MWL diaries was significantly higher than the physical demand (one aspect of MWL) reported in the experiments. This is most likely due to the fact that CPs sat

at a checking station in a consultation room whilst they carried out the accuracy checking task. In community pharmacy practice CPs and other members of the pharmacy team use standing height benches and so are on their feet whilst they carry out their work which would account for some of the difference in physical demand reports.

Another limitation of the experimental research was the time involved in accuracy checking which limited how much data could be collected from each participant. Participants only checked 50 items in total which is a very small number for a visual search study. The d' and response criterion values should be treated with some caution for this reason. Also the stimuli in the accuracy checking task are complex. This means that the signal strength or signal intensity is difficult to measure and hold constant, and therefore the signal and noise distributions may not be normally distributed which could also affect the results of these calculations (Schell, et al., 2005).

A limitation of all three studies carried out is that only CPs and pharmacy students took part. Accuracy checking technicians also, as their title suggests, carry out accuracy checks on dispensed medicines. There is some suggestion that the MWL ratings reported by CPs and pharmacy students would not be generalisable to accuracy checking technicians as Grasha (2001a; 2002b) found a difference in the MWL reports of CPs and technicians in their study. Although they didn't control for the types of tasks CPs and pharmacy technicians were undertaking which could account for the differences in the MWL scores.

7.11.3. Strengths of the MWL diary study

Through the MWL diary study some initial data on the MWL levels that UK CPs experience throughout the day was collected. This data was compared with the MWL data collected in the accuracy checking experiments. These comparisons allowed conclusions to be drawn about whether the experimental data could be generalised to real-life community pharmacy practice. The MWL diaries showed that some aspects were

similar (e.g. time pressure) and some were different (e.g. physical demand), but these differences could be explained with reference to the design of the study.

The MWL diaries were of great benefit during the CP interviews as these acted as prompts for CPs to talk about the reasons why various aspects of their MWL varied throughout the day. They were also easy for CPs to complete during their day at work, and allowed CPs to identify times when they hadn't expected their MWL to be high. It also allowed them to reflect on the aspects of their work that they found added stress or pressure to their role. This approach could be quickly and easily used by CPs and community pharmacy organisations when considering new services, or to evaluate the pressures that staff experience in their work.

7.11.4. Limitations of the MWL diary study

This diary study was designed to capture a snapshot of CPs working days and how MWL might be varying during the course of a day. This means that these ratings are not directly comparable to the ratings gained in experiment 1 and 2 as CPs were instructed to complete the diary during at least one busy and one quiet time in their pharmacy. Also, CPs were not specifically asked to rate their MWL when they were accuracy checking. This approach was taken as a few CPs in the study work with accuracy checking technicians and therefore would not routinely carry out large amounts of accuracy checking.

It is a small sample size, only 40 CPs completed the MWL diaries. A larger study may be able to identify if CPs working in the different types of community pharmacy (independent, small or medium chain, supermarket and large national chain pharmacy) have different MWL profiles.

7.11.5. Strengths of the qualitative study

The qualitative study provided many insights into the MWL diary data and the accuracy checking studies data. For example, through the CPs narratives of needing to be "in the zone" when they did their work,

analyses were carried out to identify whether changes in task engagement (measured through changes on aspects of the DSSQ) could explain the decline in CP performance seen between task 1 and 2. Additionally quotes from pharmacy students and CPs allowed for conclusions to be drawn about why some DEs were missed in the accuracy checking experiments.

The qualitative data confirmed that MWL is something that CPs and pharmacy students relate to. For example, one CP referred to mental overload as "*the cogs just start blowing up*." All the interview participants highlighted that MWL is an issue in community pharmacies and through participants' narratives the factors which led to sub-optimal levels of MWL were identified. The MWL diaries and the interviews also showed that CPs were experiencing high levels of frustration because of the way their work was designed. These levels of frustration would likely add to their MWL. This study provides the first qualitative data on the MWL experienced by CPs and how the design of CPs work can affect MWL as well as the amount of work they are asked to undertake.

The qualitative data was analysed according to Interpretative Phenomenological Analysis (IPA) which allowed the individual experience of MWL to be highlighted. Differences were found in the experiences of MWL for example, the same issue - not being able to tick things of their to-do-list - caused different types of MWL for two CPs. For one CP this led to increased performance concern because they weren't getting everything they had wanted to done. For another CP this led to increased levels of frustration. Both CPs interpreted the questions in the same way on the MWL diaries, but the stressor itself meant something qualitatively different for these two CPs.

The qualitative study also confirmed several other themes that have been reported in previous research, for example participants in the study conducted by Gidman (2011) referred to the "dispensing factory" which was similar to the "dispensing treadmill" that participants referred to in this doctoral study. Whilst qualitative research does not seek to generalise

findings, this study adds to the growing body of qualitative evidence on the demands placed on CPs.

7.11.6. Limitations of the qualitative research

The most commonly cited limitation of qualitative research is that it cannot be generalised in the same way as quantitative data. However, as previously mentioned, many themes reported by CPs and pharmacy students in this doctoral research have been reported by previous qualitative research into the workload pressures that CPs experience. As this is the first qualitative study into MWL with CPs and pharmacy students it is unknown whether these experiences are those commonly experienced by CPs and pharmacy students around the UK, or are particular to the participants who took part in the interviews.

Most of the CPs who took part in this research were pharmacy managers. This is of interest because many of the CPs who were also the pharmacy manager reported that this was a particularly demanding role and led to a large amount of task frustration and MWL, which may not be experienced by CPs who were not undertaking this dual role.

Another limitation of this research is the possibility that the CPs and pharmacy students who took part in the qualitative research and the other aspects of this research may be those who felt most under pressure or experienced the most MWL in their day to day practice. CPs and pharmacy students who do not experience these pressures may have been less interested in taking part because the study was not of relevance to them. This issue could not be measured in this research. However, CP and pharmacy student participants were purposively selected for the interviews from a pool of potential participants. This strategy meant that CPs and pharmacy students representing a range of pharmacy backgrounds and levels of experience were interviewed for this study.

7.12. Future research and directions

There are several questions that could be answered by future research that have arisen from this data. First, CPs were less successful at identifying labelling DEs than content DEs. It is not known whether this was related to the time available to carry out the checking task. Therefore a similar study could be carried out where time pressure was varied in order to identify whether this led CPs to miss different types of DEs, or whether given more time their DE detection increased.

The current study could also not comment on whether CPs missed more labelling errors because they were failing to check all aspects of the label against the prescription, or they were checking all aspects, but failed to perceive the label details correctly (e.g. due to expectations driven by top-down LTM processes). An eye-tracking study could be carried out to identify whether one or both of these explanations are relevant. If this was combined with a study varying the time pressure CPs were under (as suggested above) an eye-tracking study would be able to measure if visual search strategies changed under time pressure.

The focus of the experimental research in this doctoral study was accuracy checking. However a similar study design could be used to measure CP and pharmacy students' performance under different pressures when carrying out clinical and legal checks of prescriptions.

It would also be interesting to study the impact of payoffs and incentives for reporting false alarms to see if this improves DE detection (in particular label error detection) for CPs. Previous research carried out in the US suggests that payoffs may improve prescription checking (Schell, et al., 2006). However, this research was carried out with undergraduate psychology students and as this doctoral research has demonstrated expert pharmacists perform quite differently on tasks compared to novice pharmacists so it is not known whether this approach would be beneficial for CPs DE detection.

The qualitative research indicated that there may be differences in the type and amount of MWL that CPs who were also pharmacy managers experienced. It would be interesting to explore this through further qualitative research, possibly accompanied by a MWL diary study. In the future it is important that other members of the community pharmacy team are involved in MWL research as a quote from one student participant who regularly worked as a dispensing technician showed that often the WL of the CP can cause MWL and stress for the other members of the pharmacy team. The MWL diary study also indicated that there was a significant difference in MWL reports between CPs who worked full-time and CPs who worked part-time. Future research could explore this difference further.

A similar study into MWL has not been conducted in hospital pharmacy and it would be interesting to explore the levels of MWL that these pharmacy teams experience. This would also allow the impact of automated dispensing systems to be explored from a MWL perspective. Where community pharmacies have automated systems it would be interesting to measure the MWL and interview members of the pharmacy team to see if this has had an impact on the WL and MWL that CPs and their pharmacy teams experience.

7.13. Summary of the chapter

This chapter has discussed the results of the three studies carried out as part of this doctoral research in the context of the Cognitive Systems Model proposed by Grasha (2001b) and previous research into CPs WL and DEs. This research was also related to Hackman and Oldham's (1976; 1980) Job Characteristics Model in order to identify how CPs work could be redesigned to support them in their role. Chapter 8, the final chapter, draws conclusions from this research and makes recommendations for pharmacy practice.

CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS FOR PRACTICE

"I've worked before where I wasn't a pharmacy manager I was working with non-pharm[acist] managers where when it comes to doing the MURs and things like that we had this constant pressure. So we have to do two today you just end up not doing any sometimes [that's] just the way it is. Where you have the flexibility to do it then you just do it 'cause you enjoy doing it and [it] doesn't become a number game it's not a game of numbers not trying to reach a number and that's it. I mean I've worked in the past for a different employer where there wasn't [sic] targets for me 'cause I was a relief [pharmacist]. So there wasn't a target as such and kind of I was doing more. Where you get targets given to you it slows you down somehow it actually does slow you down."

Community Pharmacist 29

8.1. Overview of the Chapter

This final chapter presents the conclusions drawn from this doctoral research and recommendations for pharmacy practice and the training of future pharmacists.

8.2. Conclusions

- Accuracy checking is not a task which can be carried out with a 100% success rate. Only 35% of CPs, and 25% of the pharmacy students detected all the DEs in the task.

- Evidence of a relationship between DEs and MWL has been found. High MWL was linked to reduced error detection, and this relationship is modified by the level of expertise of the pharmacist. Expertise was also found to affect the number of DEs detected, and the types of DEs detected.

- Higher levels of the personality trait conscientiousness were related to higher DE detection rates.

- Distractions and interruptions were not found to affect DE detection, but did have an impact on the levels of MWL participants experienced. This finding was supported by the narratives of participants in study 3 who reported experiencing increased pressure and MWL due to interruptions and distractions in the pharmacy.

- Additional task load (high WM load condition) did not have an effect on DE detection. However participants in this condition reported significantly more task frustration (one aspect of MWL). Task frustration levels were also found to be high when CPs measured their MWL during a day of their "real-life" practice. CPs and pharmacy students in study 3 reported several examples of significant task

frustrations in their day to day work, including:

- the low control they had over their WL
- difficulty in taking breaks due to low staffing levels and high WL,
- the added pressures of combining the role of CP and pharmacy manager,
- advanced and enhanced service targets, and customer service performance indicators,
- poor lines of communication with prescribers,
- distractions and interruptions making work slower,
- no time being available for training staff,
- the drug tariff and the difficulties independent pharmacies had in sourcing medicines.

- Study 2 found that CPs' experiences of MWL can often be exceptionally high. Peaks were seen at 11 o'clock in the morning and five o'clock in the afternoon where aspects of MWL (mental, physical and temporal demand) were rated at the upper end of the NASA-TLX scale, suggesting that CPs may be mentally overloaded at these times. DE rates were not measured in study 2, and CPs MWL in study 1 did not reach these levels so the results of this research cannot conclude whether these peaks in MWL would be related to increased DE rates.

- Study 2 also highlighted times when CPs experienced mental underload. This was most pronounced at the beginning of the shift and the diary study showed that CPs reported higher levels of performance concern at this time. Increased performance concern was related to CPs feeling they were not yet "in the zone" (mentally focussed), and therefore were not in the right mind-set to be carrying out safety critical tasks.

- Some initial evidence was found that work patterns (full-time vs part-time) may have an impact on the amount of MWL that is experienced.

8.3. Recommendations for Practice

The findings of this research have implications for the regulation of pharmacists by the GPhC, particularly in relation to pharmacy supervision laws, the Responsible Pharmacist legislation and the Medicines Act 1968 (HM Government, 1968, 2006, 2008). These findings also have implications for the training of pharmacists and for organisational management of CPs. Seven recommendations for practice are made based on the findings of this research.

1. **Ensure there are no gaps in pharmacists' accuracy checking knowledge and skills**

    This study and previous research (e.g. James, 2011) has found that CPs DE detection through a final accuracy check is not fail-safe. James' (2011) study of accuracy checking competency identified areas where additional training could be targeted to address gaps in both pharmacy students and practising hospital pharmacists' knowledge on how to carry out a final accuracy check. Accredited checking technicians receive tailored training on how to carry out a final accuracy check, however this is not standard practice across schools of pharmacy in the UK who train pharmacists. Therefore CPD modules, and undergraduate degree programmes could in future include specific training on how to carry out an accuracy check and what to check. A detailed description of best practice in accuracy checking could also be specified in pharmacy standard operating procedures.

    Schools of pharmacy generally assess pharmacy students' detection of DEs through simulated checking tests, where the prevalence of DEs is high. In the future, pharmacy students could be trained and assessed on tasks where DE prevalence is low, in order to encourage them to

report false alarms and consider factors (e.g. speed of work) which may affect their perceptual sensitivity to DEs.

2. **Use of technology to reduce errors during the dispensing process**

Whilst training to reduce gaps in knowledge can be offered, it is likely that this task will continue to be susceptible to human error. Future interventions into the safety of community pharmacy work should consider other methods for reducing DEs through targeting the factors which make DEs more likely to be made at earlier stages in the process, to reduce the opportunity for errors to slip through a final accuracy check. One example would be the already available automated dispensing systems which have been found to reduce the number of DEs made at the product selection stage of the dispensing process. These systems have been successfully employed in hospital pharmacy dispensaries. However, to date, these systems have not been widely adopted community pharmacy practice, reportedly because they require a large amount of space, and are costly. Automated systems may reduce the number of DEs being made, however the few DEs that continue to be made may become harder to detect on a final accuracy check due to the lower target prevalence. So the introduction of any automated system may require a re-consideration of how the accuracy check is carried out.

Technology can also be used in other ways to support the safety of community pharmacists' work. The qualitative findings suggest that "local knowledge" of the dispensary and of regular patients is crucial to ensuring the safe and effective running of the pharmacy. The electronic patient medication records were identified as a key way to communicate information to both the regular pharmacists (so they could keep an accurate log of the care they had provided to date) and locum pharmacists so that they are able to gain some knowledge of the patients' medication history before dispensing a new or repeat

prescription. This was not a practice that all pharmacists reported making use of, but could be a tool to support the safety of their work.

3. **Consideration of the design of pharmacy tasks and creating time for breaks**

   In the qualitative follow-up study several CPs spoke about the "dispensing treadmill" and the routine, repetitive nature of their work. Also a frustration for many CPs was the difficulty they now found completing this work during the working week. In addition to this CPs spoke about difficulty taking breaks and the importance of having time to "switch off" to maintaining the safety of their work. These findings suggest that CPs and their teams would benefit from being able to take short breaks during the working day. This could be achieved through varying the types of tasks they are working on to avoid, fatigue and loss of concentration if the same task is repeated over and over. Some CPs highlighted in their narratives that they were doing this already. For most CPs in this study, taking breaks (e.g. a lunch break) was rare. This is a clear area where CPs could be supported in finding the best time for them and their pharmacy team members to take a lunch break during the working day.

4. **Support CPs in managing their workload and mental workload**

   CPs and pharmacy students who were interviewed gave several examples of strategies they used to avoid the negative consequences of high MWL. Pharmacists and pharmacy students could share best practice in minimising mental overload and in the future could be trained in strategies to minimise the impact of both mental overload and underload on the safety of their work. These strategies could be shared through existing informal networks of pharmacists, e.g. social networking sites, blogs. They could also be shared through newsletters. Other industries have newsletters which are designed to share best practice, but also anonymous reports of safety issues that have occurred. The aviation and marine industry have a newsletter of this

kind called CHIRP (see: http://www.chirp.co.uk/). Formal networks that could provide this resource, and already do on some topics include the Royal Pharmaceutical Society and the National Pharmacy Association. However, resources provided by these organisations are in some cases only available to subscribing members.

Measures of MWL could also be used at times when a new service is introduced by a community pharmacy to explore the impact this additional service has on the team's subjective experience of WL, as well as the volume of work they are carrying out.

5. **Reduce or remove distractions and interruptions from the dispensary environment**

   Distractions and interruptions were not found to affect DE detection in this study, but did have a significant impact on the MWL reported in study 1. Distractions and interruptions were also a significant stressor reported by CPs and pharmacy students in study 3. A small-scale study in the USA found that an intervention to create a sterile (distraction and interruption free) pharmacy environment led to reduced DE rates (Leporte, Ventresca, & Crumb, 2009). It is therefore recommended that a sterile dispensary is piloted in a number of UK pharmacies to explore the impact this has on CP and other pharmacy staffs' MWL and DE rates.

6. **Future research and practice interventions should account for the role of expertise when exploring factors which promote or reduce safety issues**

   The experimental phase and the qualitative phase of this thesis provided not only evidence of significant differences in CPs and pharmacy students' performance on routine pharmacy tasks, but also the factors which reduce performance. It is common practice to involve students studying at universities as participants for research of this kind. However, the findings reported in this thesis suggest that results

obtained from novice pharmacists may not be generalisable to expert practice. Nonetheless there are implications for the training of students and early years' pharmacists. Factors which explore the relationship between expertise and safe practise should be investigated in future research.

7. **Training pharmacists in principles of human factors to improve the safety of their work**

Pharmacy students receive some training in medicines safety. It is recommended that this training could also include an introduction to human factors principles relevant to pharmacy practice, including topics of MWL, models of cognition, and tools for evaluating the safety of processes (e.g. route-cause analyses) if they are not already taught. Students may also benefit from assessing their cognitive processes (e.g. through MWL and subjective states questionnaires) in order to become aware of how these mental states may vary due to the work they are carrying out and the environment they are working in. This may enable students to consider the impact these factors could have on their cognitive processes, and the safety of their work. This approach has been used in Schools of Medicine and has been well received both by those training the students (Peach et al., 2012) and the students themselves (Bamford, Taylor, & Cracknell, 2012). This training could also be extended to CPs already in practice (who may not have received such training during their pharmacy training) through continuing professional development providers. The aim of this training would be to equip students and pharmacists with knowledge about factors which can compromise the safety of their work and how they can be managed. However, as mentioned in recommendation 6 above, the results of this research indicate that expertise has a large impact on the factors which affect the safety of pharmacy work. Therefore, training and interventions should be targeted according to the pharmacists' level of expertise for the task.

8. **Improve lines of communications between CPs and prescribers**

   This recommendation has been made in previous research (e.g. Hughes & McCann, 2003). However, the narratives in study 3 show the impact that poor lines of communication on both CPs' decision making and the amount of MWL they experience (in particular due to frustration) can have. Difficulty contacting prescribers presents a patient safety risk because the time and effort involved may make CPs reluctant to double check with a prescriber an issue on a prescription. Some CPs who were interviewed felt it was important for them to individually build these relationships, but this is not feasible for CPs who work as locums. Therefore, the regulatory and professional bodies should continue to promote the pharmacist's role to the public and other healthcare professionals.

9. **Support CPs and their teams in imputing more control into their work**

   CPs and pharmacy students who were interviewed reported a lack of control over their WL as a significant frustration in their day to day work, and as a factor which contributed to their overall levels of MWL. To manage this CPs and pharmacy students reported trying to prioritise their WL as much as possible in order to reinstate some control. CPs could share these strategies as points of best practice, as suggested in recommendation 4, these could be shared through informal networks for pharmacists.

   The impact of reduced control over WL has also been linked in the discussion of the results to the effectiveness of CPs cognitive processes (Hockey & Earle, 2006), and to theories of work design and motivation (Hackman & Oldham, 1976). Allowing CPs the autonomy to manage their workload is important as it will allow for more optimal distribution of their effort throughout the day. Many CPs felt the biggest threat to WL control was the unpredictable nature of walk-in prescriptions and over the counter sales. However, an emphasis on

targets for completing enhanced and advanced services, customer satisfaction scores, and patient wait times were for some CPs another factor which reduced their ability to plan and manage their WL effectively.

It has been suggested in the discussion section of this thesis that CPs could also gain significantly more control over their WL if they were less tied to the dispensing process. However, research by Bradley et al., (2013) suggests this is not possible under current pharmacy supervision laws and the reluctance of both CPs in relinquishing this control, and pharmacy support staff feeling unable to take on new roles (HM Government, 2006, 2008).

Lack of control over WL should be a factor considered for its impact on the safety of pharmacists' work. As the role of the CP continues to expand, factors such as WL control and the impact this has on the MWL that CPs and their teams experience, should be considered. In the future, detailed studies of pharmacy work processes should be made and support for change be instigated by all concerned with safe pharmacy practice.

8.4. Summary of the thesis

This doctoral research has provided an in-depth insight into the relationship between MWL and DEs during a routine pharmacy task. MWL has been shown to be an important issue for CPs and pharmacy students, and one which they feel they have to manage in their day to day work. Pharmacy expertise was found in this research to affect the types of DEs missed, the amount of MWL experienced, and modified the impact of MWL on DE detection. This doctoral research has also added to the existing body of research into the pressures that CPs experience in their work and linked these pressures to experiences of MWL. This thesis has demonstrated that the assessment of the MWL involved in routine

pharmacy tasks has the potential to complement existing strategies for identifying workload and safety issues in community pharmacies. In the future MWL assessment could play an important role in the assessment of the safety of new services, systems (or changes to standard operating procedures), and dispensary layouts.

References

Adair, J. G. (1984). The Hawthorne effect: a reconsideration of the methodological artifact. Journal of Applied Psychology, 69(2), 334-335.

Allport, D. A., Antonis, B., & Reynolds, P. (1972). On the division of attention: a disproof of the single channel hypothesis. Quarterly Journal of Experimental Psychology, 24, 225-235.

Angelo, L. B., Christensen, D. B., & Ferreri, S. P. (2005). Impact of community pharmacy automation on workflow, workload, and patient interaction. Journal of the American Pharmacists Association, 45(2), 138-144.

Anon. (2009). Former locum handed suspended jail term for dispensing error. The Pharmaceutical Journal, 282, 401.

Anto, B., James, K. L., Barlow, D., Brinklow, N., Oborne, C. A., & Whittlesea, C. (2013). Exploratory study to identify the process used by pharmacy staff to verify the accuracy of dispensed medicines. International Journal of Pharmacy Practice, 21(4), 233-242.

Armitage, G. (2008). Double checking medicines: defence against error or contributory factor. Journal of Evaluation in Clinical Practice, 14, 513-519.

Ashcroft, D., Morecroft, C., Parker, D., & Noyce, P. R. (2005). Safety culture assessment in community pharmacy: development, face validity, and feasibility of the Manchester Patient Safety Assessment Framework. Quality and Safety in Health Care, 14, 417-421.

Ashcroft, D., Morecroft, C., Parker, D., & Noyce, P. (2006). Likelihood of reporting adverse events in community pharmacy: an experimental study. Quality and Safety in Health Care, 14, 48-52. doi: doi: 10.1136/qshc.2005.014639

Ashcroft, D., Quinlan, P., & Blenkinsopp, A. (2005). Prospective study of the incidence, nature and casues of dispensing errors in community pharmacies. Pharmacoepidemiology and Drug Safety, 14, 327-332.

Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In K. W. Spence & J. T. Spence (Eds.), The psychology of learning and motivation (Vol. 2, pp. 89-195). London: Academic Press.

Averty, P., Athenes, S., Collet, C., & Dittmar, A. (2002, 2002). Evaluating a new index of mental workload in real ATC situation using psychophysiological measures. Paper presented at The 21st Digital Avionics Systems Conference, 2002. Proceedings.

Baddeley, A. D. (2003). Working Memory: looking back and looking forward. Nature Reviews Neuroscience, 4, 829-839.

Baddeley, A. D. (2012). Working Memory: Theories, Models, and Controversies. Annual Review of Psychology, 63(1), 1-29. doi: doi:10.1146/annurev-psych-120710-100422

Baddeley, A. D., & Hitch, G. J. (1974). Working memory. The psychology of learning and motivation, 8, 47-89.

Bamford, T., Taylor, N., & Cracknell, A. (2012). Utilising human factors in patient safety: a student's perspective. Paper presented at the Balancing creativity & evidence for patient safety, National Media Museum, Bradford.

Baumber, N. (2004). Community pharmacists vote ''yes'' to new contract. The Pharmaceutical Journal, 273(7327), 773.

Beilock, S. L., Bertenthal, B. I., McCoy, A. M., & Carr, T. H. (2004). Haste does not always make waste: expertise, direction of attention, and speed versus accuracy in performing sensorimotor skills. Psychonomic Bulletin & Review, 11(2), 373-379.

Benet-Martinez, V., & John, O. P. (1998). Los Cinco Grandes across cultures and ethnic groups: Multitrait multimethod analyses of the Big Five in Spanish and English. Journal of Personality and Social Psychology, 75, 729-750.

Beso, A., Franklin, B. D., & Barber, N. (2005). The frequency and potential causes of dispensing errors in a hospital pharmacy. Pharmacy World & Science, 27, 182-190.

Bilsing-Palacio, L., & Schell, K. L. (2003). Signal probability effects on error detection performance in a quality control task. Psychological Reports, 93, 343-352.

Bleckley, M. K., Durso, F., Crutchfield, J., Engle, R., & Khanna, M. (2003). Individual differences in working memory capacity predict visual attention allocation. Psychonomic Bulletin & Review, 10(4), 884-889. doi: 10.3758/bf03196548

Block, R. A., Hancock, P. A., & Zakay, D. (2010). How cognitive load affects duration judgments: A meta-analytic review. Acta Psychologica 134 330-343.

Bolton, R. N. (1991). An exploratory investigation of questionnaire pretesting with verbal protocol analysis. Advances in consumer research, 18, 558-565.

Bolger, N., Davis, A., & Rafaeli, E. (2003). Diary Methods: Capturing Life as it is Lived. Annual Review of Psychology, 54(1), 579-616. doi: doi:10.1146/annurev.psych.54.101601.145030

Bradley, F., Schafheutle, E. I., Willis, S. C., & Noyce, P. R. (2013). Changes to supervision in community pharmacy: pharmacist and pharmacy support staff views. Health & Social Care in the Community, n/a-n/a. doi: 10.1111/hsc.12053

Braun, V., & Clarke, V. (2012). Thematic analysis. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf & K. J. Sher (Eds.), APA handbook of research methods in psychology, Vol 2: Research designs: Quantitative, qualitative, neuropsychological, and biological (pp. 57-71). Washington, DC, US: American Psychological Association.

Breakwell, G. M., Hammond, S., Fife-Schaw, C., & Smith, J. A. (2006). Preface. In G. M. Breakwell, S. Hammond, C. Fife-Schaw & J. A. Smith (Eds.), Research methods in psychology (3rd ed., pp. xviii- xxi). London: Sage Publications Ltd.

Broadbent, D. E. (1958). Perception and communication. Oxford: Pergamon.

Broadbent, D. E. (1982). Task combination and selective intake of information. Acta Psychologica, 50, 253-290.

Burford, M. E., Yeck, A. E., Tucker, J. A., Barker, L. M., & Pasupathy, K. S. (2011). Stressors in the pharmacy: an observational study of interruptions. Proceedings of the Human Factors and Ergonomics Society Anuual Meeting 55, 1970-1974.

Byrne, A. (2011). Measurement of Mental Workload in Clinical Medicine: A Review Study. Anesthesiology and Pain Medicine, 1(2), 90-94.

Cannell, C. F., Fowler, F. J., & Marquis, K. H. (1968). The influence of interviewer and respondent psychological and behavioural variables on the reporting in household interviews Vital and health statistics (Vol. 2). Washington, DC: Public Health Service.

Chapanis, A. (2004). Foreward. In M. S. Bogner (Ed.), Misadventures in health care: inside stories (pp. xi-xiv). Mahwah, NJ: Erlbaum.

Cherry, E. C. (1953). Some experiments on the recognition of speech with one and two ears. Journal of the Acoustical Society of America, 25, 975-979.

Chua, S.-S., Wong, I. C. K., Edmondson, H., Allen, C., Chow, J., Peacham, J., . . . Grantham, J. (2003). A feasibility study for recording of dispensing errors and 'near misses' in four UK primary care pharmacies. Drug Safety, 26(11), 803-813.

Chui, M., Mott, D., & Rodriguez, E. (2011). Relationship of community pharmacists' mental workload with perceived task performance: A human factors approach. Journal of the American Pharmacists Association, 51(2), 253.

Chun, M. M., & Wolfe, J. M. (1996). Just say no: how are visual searches terminated when there is no target present? Cognitive Psychology, 30, 39-78.

CoAcS. ePMRx (Version 2.0). Retrieved from http://www.epmrx.com/

Cohen, G. (1993). Memory Systems. In G. Cohen, G. Kiss & M. LeVoi (Eds.), Memory: current issues (2nd ed., pp. 65-70). Buckingham: Open University Press.

Cohen, J. (1992). A power primer. Psychological Bulletin, 112(1), 155-159.
Cohen, M. R. (2007). Causes of medication errors. In M. R. Cohen (Ed.), Medication errors (2nd ed., pp. 55-66). Washington DC: American Pharmacists Association.

Cohen, N. J., & Squire, L. R. (1980). Preserved learning and retention of pattern-analyzing skill in amnesia: dissociation of knowing how and knowing that. Science 210, 207-209.

Colflesh, G. J. H., & Conway, A. R. A. (2007). Individual differences in working memory capacity and divided attention in dichotic listening. Psychonomic Bulletin and Review, 14, 699-703.

Collins, D. (2003). Pretesting survey instruments: An overview of cognitive methods. Quality of Life Research, 12(3), 229-238. doi: 10.1023/a:1023254226592

Conway, A. R. A., Cowan, N., & Bunting, M. F. (2001). The cocktail party phenomenon revisited: the importance of working memory capacity. Psychonomic Bulletin and Review, 8, 331-335.

Corteen, R. S., & Dunn, T. H. (1973). Shock associated words in a nonattended message: A test for momentary awareness. Journal of Experimental Psychology, 308–313.

Cox, S., & Flin, R. (1998). Safety culture: Philosopher's stone or man of straw? Work & Stress, 12(3), 189-201. doi: 10.1080/02678379808256861

Creswell, J. W., Fetters, M. D., & Ivankova, N. V. (2004). Designing a mixed methods study in primary care. Annals of Family Medicine, 2, 7-12.

Cruise, C. E., Broderick, J., Porter, L., Kaell, A., & Stone, A. A. (1996). Reactive effects of diary self-assessment in chronic pain patients. Pain, 67(2–3), 253-258. doi: http://dx.doi.org/10.1016/0304-3959(96)03125-9

Crown Prosecution Service. (2013). Legal guidance: Medicines Act 1968 Retrieved 16.07.2013, from http://www.cps.gov.uk/legal/l_to_o/medicines_act_1968/#a02

Davis, A., & Bremner, G. (2006). The experimental method in psychology. In G. M. Breakwell, S. Hammond, C. Fife-Schaw & J. A. Smith (Eds.), Research methods in psychology (3rd ed., pp. 64-88). London: Sage Publications Ltd.

Day Lewis Pharmacy. (2013). About us. Retrieved 1.1.13, from http://www.daylewisplc.co.uk/about

Dekker, S. (2011). Patient safety: a human factors approach (Kindle Edition ed.). Boca Raton, FL: CRC Press.

Della Sala, S., Gray, C., Baddeley, A., Allamano, N., & Wilson, L. (1999). Pattern span: a tool for unwelding visuo-spatial memory. Neuropsychologia, 37, 1189-1199. DiCicco-Bloom, B., & Crabtree, B. F. (2006). The qualitative research interview. Medical Education 40, 314-321.

Dodhia, R. M., & Dismukes, R. K. (2009). Interruptions create prospective memory tasks. Applied Cognitive Psychology, 23, 73-89.

Donyai, P. (2012). Social and cognitive pharmacy: theory and case studies. London: Pharmaceutical Press.

Eden, M., Schafheutle, E. I., & Hassell, K. (2009). Workload pressure among recently qualified pharmacists: an exploratory study of intentions to leave the profession. International Journal of Pharmacy Practice, 17, 181-187. doi: 10.1211/ijpp/17.03.0009

Electronic Code of Federal Regulations. (2013). Aeronautics and space: Operating requirements 14 (Part 121): domestic, flag and supplemental operations, subpart T - flight operations. Available at: http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&SID=c19187b108a2913a8d487b29e36e2696&rgn=div8&view=text&node=14:3.0.1.1.7.20.3.8&idno=14

Endsley, M. R. (1995). Toward a theory of situation awareness in dynamic systems. Human Factors, 37(1), 32-64.

Ericsson, K. A., Krampe, R. T., & Tesch-Romer, C. (1993). The role of deliberate practice in the acquisition of expert performance. Psychological Review, 100(3), 363-406.

Ericsson, K. A., & Simon, H. A. (1993). Protocol Analysis - Revised Edition. Cambridge (MA): MIT Press.

Ericsson, K. A., & Towne, T. J. (2010). Expertise. Advanced Review, 1, 404-416.

Eysenck, M. W., & Keane, M. T. (1995). Cognitive Psychology: A students handbook (3rd ed.). Hove, UK: Lawrence Erlbaum.

Fenigstein, A., Scheier, M. F., & Buss, A. H. (1975). Public and private self-consciousness: Assessment and theory Journal of Consulting and Clinical Psychology, 43, 522-527.

Fife-Schaw, C. (2006). Questionnaire design. In G. M. Breakwell, S. Hammond, F. Fife-Schaw & J. A. Smith (Eds.), Research Methods in Psychology: (3rd ed., pp. 210-231). London: Sage

Fitts, P. M., & Jones, R. (1947). Analysis of factors contributing to 460 pilot-error experiences in operating aircraft controls. Selected papers on human factors in the design and use of control systems. New York, NY: Dover.

Flin, R., Bromiley, M., Buckle, P., & Reid, J. (2013). Changing behaviour with a human factors approach. BMJ, 346. doi: 10.1136/bmj.f1416

Flin, R., Burns, C., Mearns, K., Yule, S., & Robertson, E. M. (2006). Measuring safety climate in health care. Quality and Safety in Health Care, 15(2), 109-115. doi: 10.1136/qshc.2005.014761

Flynn, E. A., Barker, K. N., Gibson, J. T., Pearson, R. E., Berger, B. A., & Smith, L. A. (1999). Impact of interruptions and distractions on dispensing errors in an ambulatory care pharmacy. Americal Journal of Health-System Pharmacy, 56(1), 1319-1325.

Flynn, E. A., Barker, K. N., Gibson, J. T., Pearson, R. E., Smith, L. A., & Berger, B. A. (1996). Relationships between ambient sounds and the accuracy of pharmacists' prescription-filling performance. Human Factors, 38(4), 614-622.

Fonteyn, M. E., Kuipers, B., & Grobe, S. J. (1993). A description of Think Aloud Method and Protocol Analysis. Qualitative Health Research, 3, 430-441.

Franklin, B. D., & O'Grady, K. O. (2007). Dispensing errors in community pharmacy: frequency, clinical significance and potential impact of authentication at the point of dispensing. International Journal of Pharmacy Practice, 15, 273-281. doi: 10.1211/ijpp.15.4.0004

Franklin, B. D., O'Grady, K. O., Voncina, L., Popoola, J., & Jacklin, A. (2008). An evaluation of two automated dispensing machines in UK hospital pharmacy. International Journal of Pharmacy Practice, 16, 47-53.

French, D. P., & Sutton, S. (2011). Does measuring people change them? The Psychologist, 24(4), 272-274.

Furness, P. J., & Garrud, P. (2010). Adaptation after facial surgery: using the diary as a research tool. Qualitative Health Research, 20(2), 262-272. doi: 10.1177/1049732309357571

Galy, E., Cariou, M., & Mélan, C. (2012). What is the relationship between mental workload factors and cognitive load types? International Journal of Psychophysiology 83, 269-275.

General Pharmaceutical Council. (2010). Guidance note: responding to complaints and concerns. London: Standards Advisory Team.

General Pharmaceutical Council. (2013). About us. Retrieved 01.11.2013, from http://www.pharmacyregulation.org/about-us

Gidman, W. (2011). Increasing community pharmacy workloads in England: causes and consequences. International Journal of Clinical Pharmacy, 33(3), 512-520. doi: 10.1007/s11096-011-9498-x

Gidman, W., Day, J., Hassell, K., & Payne, K. (2009). Delivering health care through community pharmacies: Are working conditions deterring female pharmacists' participation? Journal of Health Services Research and Policy, 14(3), 141-149.

Gidman, W. K., Hassell, K., Day, J., & Payne, K. (2007). The impact of increasing workloads and role expansion on female community pharmacists in the United Kingdom. Research in Social and Administrative Pharmacy, 3(3), 285-302.

Gidman, W., & Oppon-Agyapomaa, N. (2010). Can community pharmacy workloads be quantified? International Journal of Pharmacy Practice, 18, 40.

Glaser, B. G., & Strauss, A. L. (1967). The discovery of grounded theory: strategies for qualitative research. Chicago, IL: Aldine.

Gopher, D., & Donchin, E. (1986). Workload: an examination of the concept. In K. R. Boff, L. Kaufman & J. P. Thomas (Eds.), Handbook of perception and human performance (Vol. II, pp. 41-41 to 41-49). New York: Wiley.

Graf, P., & Schachter, D. L. (1985). Implicit and explicit memories for new associations in normal and amnesic subjects. Journal of Experimental Psychology: Learning, Memory, & Cognition, 10, 164-178.

Grasha, A. F. (2001a). Misconceptions about pharmacy workload. Canadian Pharmaceutical Journal, 134(3), 26-35.

Grasha, A. F. (2001b). Understanding medication errors: a cognitive systems approach. Medscape.

Grasha, A. F. (2002a). Psychosocial factors, workload and risk of medication errors. US Pharmacist, 27(4), HS32-52.

Grasha, A. F. (2002b). Tools for the reflective practitioner: using self-monitoring, personal feedback and goal setting to reduce error Health Notes: Quality Assurance - Preventing Medication Errors (Vol. 1, pp. 19-24). San Francisco (CA): California State Board of Pharmacy

Grasha, A. F., & O'Neill, M. (1996). Cognitive processes in medication errors. US Pharmacist, 96, 96-109.

Grasha, A. F., Reilley, S., Schell, K. L., & Tranum, D. (2001). Process and delayed verification errors in community pharmacy University of Cincinnati

Grasha, A. F., & Schell, K. L. (2001). Psychosocial factors, workload, and human error in a simulated pharmacy dispensing task. Perceptual and Motor Skills, 92(1), 53-71.

Gorard, S. (2007). Mixing methods is wrong: an everyday approach to educational justice. Paper presented at the British Educational Research Association Annual Conference, Institatue of Education, University of London. http://www.leeds.ac.uk/educol/documents/165457.htm

Green, D. M., & Swets, J. A. (1988). Signal detection theory and psychophysics New York: Wiley.

Green, J., & Thorogood, N. (2004). Qualitative methods for health research. London: Sage.

Hackman, J. R., & Oldham, G. R. (1976). Motivation through the design of work: test of a theory. Organizational Behavior and Human Performance, 16(2), 250-279. doi: http://dx.doi.org/10.1016/0030-5073(76)90016-7

Hackman, J. R., & Oldham, G. R. (1980). Work redesign. Reading, MA: Addison-Wesley Publishing Company Inc.

Hancock, P. A., & Caird, J. K. (1993). Experimental evaluation of a model of mental workload. Human Factors, 35(3), 413-429.

Hancock, P. A., Vercruyssen, M., & Rodenburg, G. J. (1992). The effect of gender and time-of-day on time perception and mental workload. Current Psychology: Research & Reviews, 11(3), 203-225.

Hancock, P. A., Williams, G., & Manning, C. M. (1995). Influence of Task Demand Characteristics on Workload and Performance, The International Journal of Aviation Psychology, 5(1), 63-86.

Hart, S. G. (2006). NASA-Task Load Index (NASA-TLX); 20 years later. Proceedings of the Human Factors and Ergonomics Society Anuual Meeting, 50, 904-908.

Hart, S. G., & Staveland, L. E. (1988). Development of the NASA-TLX (Task Load Index); results of empirical and theoretical research. In P. A. Hancock & N. Meskkati (Eds.), Human Mental Workload. Amsterdam, Netherlands: North-Esland.

Harvey, J., Avery, A. J., Waring, J., & Barber, N. (2012). The socio-technical organisation of community pharmacies as a factor in the Electronic Prescription Service release two implementation: a qualitative study. BMC Health Services Research, 12, 471-482.

Hassell, K. (2012). CPWS Briefing Paper: GPhC Register Analysis 2011. Manchester: CPWS.

Hassell, K., & Eden, M. (2006). Workforce update - joiners, leavers, and practising and non-practising pharmacists on the 2005 register. Pharmaceutical Journal, 276, 40-42.

Hassell, K., Seston, E. M., Schafheutle, E. I., Wagner, A., & Eden, M. (2011). Workload in community pharmacies in the UK and its impact on patient safety and pharmacists' well-being: A review of the evidence. Health and Social Care in the Community, 19(6), 561-575.

Heatherton, T. F., & Polivy, J. (1991). Development of a scale for measuring state self-esteem. Journal of Personality and Social Psychology, 60, 895-910.

Heidegger, M. (1962). Being and time. Oxford, England: Blackwell.

HM Government. (1968). Medicines Act 1968: Chapter 67. Crown Publications: London

HM Government. (2006). Health Act 2006. Crown Publications: London

HM Government. (2008). The Medicines (Pharmacies) (Responsible Pharmacist) Regulations (2008). Crown Publications: London

Hockey, G. R. J. (1997). Compensatory control in the regulation of human performance under stress and high workload: A cognitive-energetical framework. Biological Psychology, 45(1–3), 73-93. doi: http://dx.doi.org/10.1016/S0301-0511(96)05223-4

Hockey, G. R. J. (2002). Human performance in the working environment. In P. Warr (Ed.), Psychology at Work (5th ed.). London, UK: Penguin.

Hockey, G. J. R., & Earle, F. (2006). Control over the scheduling of simulated office work reduces the impact of workload on mental fatigue and task performance. Journal of Experimental Psychology: Applied, 12(1), 50-65.

Holden, R. J., Patel, N. R., Scanlon, M. C., Shalaby, T. M., Arnold, J. M., & Karsh, B.-T. (2010). Effects of mental demands during dispensing on perceived medication safety and employee well-being: A study of workload in pediatric hospital pharmacies Research in Social and Administrative Pharmacy, 6(4), 293-306.

HSIC. (2013). Electronic prescription service. Retrieved 1.11.13, from http://systems.hscic.gov.uk/eps

Hughes, C. M., & McCann, S. (2003). Perceived interprofessional barriers between community pharmacists and general practitioners: a qualitative assessment. The British Journal of General Practice, 53(493), 600-606.

Hutchins, S. D., Wickens, C. D., Carolan, T. F., & Cumming, J. M. (in press). A meta-analysis: the influence of cognitive load on transfer with error prevention training methods. Human Factors.

Ilkowska, M., & Engle, R. (2010). Trait and State Differences in Working Memory Capacity. In A. Gruszka, G. Matthews & B. Szymura (Eds.), Handbook of Individual Differences in Cognition (pp. 295-320): Springer New York.

Information Services Division Scotland. (2012). Prescribing & Medicines Prescription Cost Analysis: Summary Statistics for financial year 2011/12.

Irwin, A., Mearns, K., Watson, M., & Urquhart, J. (2013). The effect of proximity, tall man lettering, and time pressure on accurate visual perception of drug names. Human Factors, 55, 253-266.

ISO. (1991). Ergonomic principles related to mental work-load (Vol. ISO 10075:1991). Geneva: ISO,.

ISO. (2013). About us: structure and governance. Retrieved 12.06.2013, from http://www.iso.org/iso/home/about/about_governance.htm

James, K. L. (2011). Are trainee pharmacists and qualified pharmacists competent at accuracy checking dispensed medicines. Higher Education Research Network Journal, 2, 17-27.

James, K. L., Barlow, D., Bithell, A., Burfield, R., Hiom, S., Lord, S., . . . Whittlesea, C. (2011). Measuring dispensary workload: A comparison of the event recording and direct time techniques. International Journal of Pharmacy Practice, 19(4), 264-275.

James, K. L., Barlow, D., Bithell, A., Hiom, S., Lord, S., Oakley, P., . . . Whittlesea, C. (2013). The impact of automation on pharmacy staff experience of workplace stressors. International Journal of Pharmacy Practice, 21(2), 105-116.

James, K. L., Barlow, D., Bithell, A., Hiom, S., Lord, S., Pollard, M., . . . Whittlesea, C. (2013). The impact of automation on workload and dispensing errors in a hospital pharmacy. International Journal of Pharmacy Practice, 21(2), 92-104.

James, K. L., Barlow, D., Hiom, S., & Whittlesea, C. (2008). Development and use of the critical incident technique in evaluating casues of dispensing incidents. International Journal of Pharmacy Practice, 16, 239-249.

James, K. L., Barlow, D., McArtney, R., Hiom, S., Roberts, D., & Whittlesea, C. (2009). Incidence, type and causes of dispensing errors: A review of the literature. International Journal of Pharmacy Practice, 17(1), 9-30. doi: 10.1211/ijpp.17.1.0004

James, K. L., Davies, J. G., Kinchin, I., Patel, J. P., & Whittlesea, C. (2010). Understanding vs. competency: the case of accuracy checking dispensed medicines

in pharmacy. Advances in Health Sciences Education, 15(5), 735-747. doi: 10.1007/s10459-010-9234-7

Jarrett, C. (2011). The rough guide to psychology: an introduction to human behaviour and the mind: Rough Guides.

John, O. P., Donahue, E. M., & Kentle, R. L. (1991). The Big Five Inventory--Versions 4a and 54. Berkeley, CA: : University of California,Berkeley, Institute of Personality and Social Research.

John, O. P., Naumann, L. P., & Soto, C. J. (2008). Paradigm Shift to the Integrative Big-Five Trait Taxonomy: History, Measurement, and Conceptual Issues. In O. P. John, R. W. Robins & L. A. Pervin (Eds.), Handbook of personality: Theory and research New York, NY: Guildford Press.

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. Journal of Mixed Methods Research, 1, 112-133.

Karasek, R. A. (1979). Job demands, job decision latitude, and mental strain: implications for job design. Administrative Science Quarterly, 24, 285-308.

Koelega, H. S. (1992). Extraversion and vigilance performance: 30 years of inconsistencies. Psychological Bulletin, 112(2), 239-258. doi: 10.1037/0033-2909.112.2.239

Kohn, K. T., Corrigan, J. M., & Donaldson, M. S. (1999). To Err Is Human: Building a Safer Health System. Washington DC: National Academy Press.

Latham, K., Waller, S., & Schaitel, J. (2011). Do best practice guidelines improve the legibility of pharmacy labels for the visually impaired? Opthalmic & Physiological Optics, 31, 275-282.

Lavie, N. (2005). DIstracted and confused: selective attention under load. Trends in Cognitive Sciences, 9(2), 75-82.

Lavie, N., Hirst, A., De Fockert, J. W., & Viding, E. (2004). Load theory of selective attention and cognitive control. Journal of Experimental Psychology: General, 133, 339-354.

Lazarus, R. S., & Folkman, S. (1987). Transactional theory and research on emotions and coping. European Journal of Personality, 1(3), 141-169. doi: 10.1002/per.2410010304

Leape, L. L., W., B. D., J., C. D., Cooper, J., Demonaco, H. J., Gallivan, T., . . . Vliet, M. V. (1995). SYstems analysis of adverse drug events. JAMA, 274(1), 35-43. doi: 10.1001/jama.1995.03530010049034

Leporte, L., Ventresca, E. C., & Crumb, D. J. (2009). Effect of a distraction-free environment on medication errors. American Journal of Health-System Pharmacy, 66(9), 795-796.

Lin, A. C., Huang, Y. C., Punches, G., & Chen, Y. (2007). Effect of a robotic prescription-filling system on pharmacy staff activities and prescription-filling time. American Journal of Health-System Pharmacy, 64(17), 1832-1839.

Luximon, A., & Goonetilleke, R. S. (2001). Simplified subjective workload assessment technique. Ergonomics, 44(3), 229-243.

Lynskey, D., Haigh, S. J., Patel, N., & Macadam, A. B. (2007). Medication errors in community pharmacy: an investigation into the types and potential causes. International Journal of Pharmacy Practice, 15, 105-112.

Macmillan, N. A., & Creelman, C. D. (2005). Detection Theory. Mahwah, NJ: Lawrence Erlbaum Associates.

Matthews, G., Campbell, S. E., Falconer, S., Joyner, L., Huggins, J., Gilliland, K., . . . Warm, J. S. (2002). Fundamental dimensions of subjective state in performance settings: task engagement, distress and worry. Emotion, 2, 315-340.

Matthews, G., Davies, D. R., Westerman, S. J., & Stammers, R. B. (2000). Human Performance: Cognition, stress and individual differences. Hove, UK: Psychology Press.

Matthews, G., Emo, A. K., Funke, G., Roberts, R. D., Zeidner, M., Costa, P. T., & Schulze, R. (2006). Emotional intelligence, personality and task induced stress. Journal of Experimental Psychology: Applied, 12(2), 96-107. doi: 10.1037/1076-898X.12.2.96

Matthews, G., Jones, D. M., & Chamberlain, A. G. (1990). Refining the measurement of mood: the UWIST Mood Adjective Checklist. British Journal of Psychology, 81, 17-42.

Matthews, G., Joyner, L., Gilliland, K., Campbell, S. E., Huggins, J., & Falconer, S. (1999). Validation of a comprehensive stress state questionnaire: Towards a state "Big Three"? In I. Mervielde, I. J. Deary, F. De Fruyt & F. Ostendorf (Eds.), Personality Psychology in Europe (Vol. 7, pp. 335-350). Tilburg, The Netherlands: Tilburg University Press.

McGrew, K. S. (2005). The Cattell-Horn-Carroll theory of cognitive abilities: past, present, and future. In D. P. Flanagan & P. L. Harrison (Eds.), Contemporary Intellectual Assessment: Theories, Tests, and Issues (2nd ed., pp. 136-181). New York: The Guildford Press.

McIlvane, W. B. (2007). Situational awareness in the operating room: a primer for the anaesthesiologist. Seminars in Anesthesia, Perioperative Medicine and Pain, 26, 167-172.

Medical Careers. (2013). General Practice. Retrieved 01.11.2013, from http://www.medicalcareers.nhs.uk/specialty_pages/general_practice.aspx

Merleau-Ponty, M. (1962). Phenomenology of perception. London, England: Routledge & Kegan Paul.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. Psychological Review, 63, 81-97.

Moray, N. (1967). Where is capacity limited? A survey and a model. Acta Psychologica, 27, 84-92.

Nachreiner, F. (1995). Standards for ergonomics principles relating to the design of work systems and to mental workload. Applied Ergonomics, 26(4), 259-263.

Newell, A., & Simon, H. A. (1972). Human problem solving. Englewood Cliffs, NJ: Prentice-Hall.

News Team. (2013). Confidence in pharmacy's financial future low. The Pharmaceutical Journal, 290, 692.

News Team. (2013b). Decriminalisation of dispensing errors could take up to three years. The Pharmaceutical Journal, 290, 98.

Ng, T. W. H., Sorensen, K. L., & Eby, L. T. (2006). Locus of control at work: a meta-analysis. Journal of Organizational Behavior, 27, 1057-1087.

NHS Careers. (2013). Pharmacy technician. Retrieved 1.1.13, from http://www.nhscareers.nhs.uk/explore-by-career/pharmacy/pharmacy-technician/

NHS Choices. (2013). The NHS in England. Retrieved 1.1.13, from http://www.nhs.uk/nhsengland/thenhs/about/pages/authoritiesandtrusts.aspx

Norman, D. A. (1981). Categorization of action slips. Psychological Review, 88(1), 1-15.

Norman, D. A., & Shallice, T. (1986). Consciousness and self-regulation, advances in research and theory (. in Consciousness and Selfregulation. Advances in Research and Theory (eds Davidson, R. J., Schwarts, G. E. & Shapiro, D.) 1–18 (Plenum, New York, 1986). ed.). New York: Plenum.

Noyes, J. M., & Bruneau, D. P. (2007). A self-analysis of the NASA-TLX workload measure. Ergonomics, 50(4), 514-519.

NPSA. (2007a). Design for patient safety: a guide to the design of dispensed medicines (1st ed.). London: NPSA.

NPSA. (2007b). A guide to the dispensing environment Design for patient safety (1st ed.). London.

NPSA. (2011). Summary of patient safety incident data reported to the National Reporting and Learning System in the last quarter of the year (up to March 2011) Retrieved 12/08/2011, from: http://www.nrls.npsa.nhs.uk/resources/collections/quarterly-data-summaries/?entryid45=131140

Nygren, T. E. (1991). Psychometric properties of subjective workload measurement techniques: Implications for their use in the assessment of perceived mental workload. Human Factors, 33(1), 17-33.

Office of Behavioural and Social Sciences Research. (2001). Qualitative methods in health research: opportunities and considerations in application and review. Bethesda (MD): National Institutes of Health.

Oldham, G. R., & Hackman, J. R. (2005). How job characteristics theory happened. In K. G. Smith & M. A. Hitt (Eds.), Great minds in management: The process of theory development (pp. 151–170). New York: Oxford University Press.

Oliver, R., Bjoertomt, O., Greenwood, R., & Rothwell, J. (2008). 'Noisy patients' - can signal detection theory help? Nature Clinical Practice, 4(6), 306-316.

Oskenberg, L., Cannell, C. F., & Kalton, G. (1991). New strategies for pretesting survey questions. Journal of Official Statistics, 7(3), 349-365.

Paas, F., Tuovinen, J. E., Tabbers, H., & Van Gerven, P. W. M. (2003). Cognitive Load Measurement as a Means to Advance Cognitive Load Theory. Educational Psychologist, 38(1), 63 - 71.

Paas, F., & Van Merrienboer, J. G. (1994). Instructional control of cognitive load in the training of complex cognitive tasks. Educational Psychology Review, 6(4), 351-371.

Paas, F., & Van Merrienboer, J. G. (1993). The efficiency of instructional conditions: An approach to combine mental effort and performance measures. Human Factors, 35(4), 737-743.

Parasuraman, R. (2013). Neuroergonomics: brain inspired cognitive engineering. In J. D. Lee & A. Kirlik (Eds.), The Oxford handbook of cognitive engineering (pp. 159-177). New York: Oxford University Press.

Peach, L., Taylor, N., Robins, V., Lawton, R., Kenny, L., & Torevell, H. (2012). Junior doctor involvement in implementing patient safety guidelines. Paper presented at

the Balancing creativity and evidence for patient safety conference, National Media Museum Bradford.

Pervin, L. A., & John, O. P. (2001). Trait theory: the five-factor model; applications and evaluation of trait approaches to personality Personality: theory and research (8th ed., pp. 253-295). New York: John Wiley & Sons.

Pharmaceutical Services Negotiating Committee. (2013). Advanced services funding Retrieved 21.07.2013, from: http://www.psnc.org.uk/pages/advanced_ services_fundinghtml.html

Pharmaceutical Services Negotiating Committee. (2013b). Medicine use review (MUR). Retrieved 1.11.13, from http://psnc.org.uk/services-commissioning/advanced-services/murs/

Phipps, D. L., & Ashcroft, D. M. (2011). Psychosocial influences on safety climate: evidence from community pharmacies. BMJ Quality & Safety. doi: 10.1136/bmjqs.2011.051912

Phipps, D. L., Malley, C., & Ashcroft, D. M. (2012). Job characteristics and safety climate: the role of effort-reward and demand-control-support models. Journal of occupational health psychology, 17(3), 279-289.

Phipps, D., Noyce, P., Parker, D., & Ashcroft, D. (2009). Medication safety in community pharmacy: a qualitative study of the sociotechnical context. BMC Health Services Research, 9(1), 158.

Pistrang, N., & Barker, C. (2012). Varieties of qualitative research: A pragmatic approach to selecting methods. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf & K. J. Sher (Eds.), APA handbook of research methods in psychology, Vol 2: Research designs: Quantitative, qualitative, neuropsychological, and biological (pp. 5-18). Washington DC, US: American Psychological Association.

Prescribing and Primary Care team. (2012). General Pharmaceutical Services in England 2002-03 to 2011-12: Health and Social Care Information Centre.
Proctor, R., & Vu, K. P. L. (2010). Cumulative Knowledge and Progress in Human Factors. Annual Review of Psychology, 61, 623-651.

Rasmussen, J. (1982). Human errors: a taxonomy for describing human malfunction in industrial installations. Journal of Occupational Accidents, 4(2), 311-333.

Rasmussen, J. (1983). Skills, Rules, and Knowledge; Signals, Signs, and Symbols, and Other Distinctions in Human Performance Models. IEEE transactions on systems, man, and cybernetics, SMC-13(3), 257-266.

Rasmussen, J., & Vicente, K. J. (1989). Coping with human errors through system design: implications for ecological interface design. International Journal of Man-Machine Studies, 31, 517-534.

Reason, J. (1988). Modelling the Basic Error Tendencies of Human Operators. Reliability Engineering and System Safety, 22, 137-153.

Reason, J. (1990). Human Error. Cambridge: Cambridge University Press.

Reason, J. (1995). Understanding adverse events: human factors. Quality in Health Care, 4(2), 80-89. doi: 10.1136/qshc.4.2.80

Reason, J. (2000). Human error: models and management. British Medical Journal, 320, 358-360.

Reason, J. (2004). Beyond the organisational accident: the need for "error wisdom" on the frontline. Quality and Safety in Health Care, 13(suppl 2), ii28-ii33.

Recarte, M. A., & Nunes, L. M. (2003). Mental workload while driving: effects on visual search, discrimination and decision making. Journal of Experimental Psychology: Applied, 9(2), 119-137.

Reilley, S., Grasha, A. F., Matthews, G., & Schafer, J. (2003). Automatic-controlled information processing and error detection in a simulated pharmacy-verification task. Perceptual and Motor Skills, 97, 151-174.

Reilley, S., Grasha, A. F., & Schafer, J. (2002). Workload, error detection and experienced stress in a simulated pharmacy verification task. Perceptual and Motor Skills, 95, 27-46.

Revelle, W. (1993). Individual differences in personality and motivation: 'non-cognitive determinants of cognitive performance'. In A. Baddeley & L. Weiskrantz (Eds.), Attention: selection, awareness and control: a tribute to Donald Broadbent (pp. 346-373). Oxford: Oxford University Press.

Ritchie, J., & Spencer, L. (1994). Qualitative data analysis for applied policy research. In A. Bryman & R. G. Burgess (Eds.), Analysing qualitative data (pp. 173-194). London: Routledge.

Rose, M. I. (1987). Type A behaviour pattern: a concept revisited. Canadian Medical Association Journal, 136, 345-350.

Rouse, W. B., Edwards, S. L., & Hammer, J. M. (1993). Modeling the dynamics of mental workload and human performance in complex systems. IEEE transactions on systems, man, and cybernetics, 23(6), 1662-1671.

RPS, & PPRT. (2009). Workload pressure and the pharmacy workforce: supporting professionals and protecting the public. Turning evidence into action. Report and Outcomes of the Joint Royal Pharmaceutical Society of Great Britain and the Pharmacy Practice Research Trust Symposium.

RPS Support. (2011). Medicines, Ethics and Practice: the professional guide for pharmacists (35 ed.). London: Royal Pharmaceutical Society of Great Britain.

Rumelhart, D. E., & McClelland, J. L. (1986). Parallel Distributed Processing: Explorations in the Microstructure of Cognition (Vol. 1). Cambridge (MA): MIT Press.

Safren, M. A., & Chapanis, A. (1959). A critical incident study of hospital medication errors. Hospitals, 16, 1060.

Sarason, I. G., Sarason, B. R., Keefe, D. E., Hayes, B. E., & Shearin, E. N. (1986). Cognitive interference: Situational determinants and traitlike characteristics. Journal of Personality and Social Psychology, 51, 215-226.

Sartre, J. P. (1943). Being and nothingness. New York, NY: Washington Square Press.

Schell, K. L., & Cox-Fuenzalida, L.-E. (2005). Neuroticism and quality control in health services: a laboratory simulation. Current Psychology, 24(4), 231-241.

Schell, K. L., & Grasha, A. F. (2000). State anxiety, performance accuracy, and work pace in a simulated pharmacy dispensing task. Perceptual and Motor Skills, 90, 547-561.

Schell, K. L., & Grasha, A. F. (2001). Interactive effects of sex and psychosocial interventions on work pace and accuracy in a self-paced product-assembly task. Perceptual and Motor Skills, 93, 879-898.

Schell, K. L., Hunsaker, C., & Kelley, K. (2006). Extending the effects of salience and payoffs on stimulus discrimination: an experimental simulation of prescription checking. Perceptual and Motor Skills, 103(2), 375-386.

Schell, K. L., & Reilley, S. P. (2004). Quality control pharmacy tasks: big five personality model and accuracy of error detection. Psychological Reports, 94(3c), 1301-1311. doi: 10.2466/pr0.94.3c.1301-1311

Schell, K. L., Reilley, S., Grasha, A. F., & Tranum, D. (2003). Improving accuracy in simulated pharmacy assembly tasks using workspace interventions to enhance the cognitive environment. Perceptual and Motor Skills, 96, 915-926.

Schell, K. L., Woodruff, A., Corbin, G. B., & Melton, E. C. (2005). Trait and state predictors of error detection accuracy in a simulated quality control task. Personality and Individual Differences, 39, 47-60. doi: 0.1016/j.paid.2004.12.003

Selye, H. (1976). Stress in health and disease. Boston (MA): Butterworth.

Seston, E., & Hassell, K. (2011). Workforce update - joiners, leavers, and practising and non-practising pharmacists on the 2010 register. Pharmaceutical Journal, 286, 473-476.

Seston, E., & Hassell, K. (2012). Briefing Paper: GPhC Pharmacy Technician Register Analysis 2012. Manchester: Centre for Pharmacy Workforce Studies.

Sharit, J. (2003). Perspectives on computer aiding in cognitive work domains: toward predictions of effectiveness and use. Ergonomics, 46, 126-140.

Sharit, J. (2006). Human Error. In G. Salvendy (Ed.), Human Factors and Ergonomics (3rd ed.). Hoboken (NJ): John Wiley & Sons.

Shaw, T. H., Matthews, G., Warm, J. S., Finomore, V. S., Silverman, L., & Costa, P. T. (2010). Individual differences in vigilance: personality, ability and states of stress. Journal of Research in Personality, 44(3), 297-308.

Smith, J. A. (1996). Beyond the divide between cognition and discourse: using interpretative phenomenological analysis in health psychology. Psychology & Health, 11, 261-271.

Smith, J. A., & Eatough, V. (2006). Intepretative Phenomenological Analysis. In G. M. Breakwell, S. Hammond, C. Fife-Schaw & J. A. Smith (Eds.), Research methods in psychology (3rd ed., pp. 322-341). London: Sage Publications Ltd.

Smith, J. A., Flowers, P., & Larkin, M. (2009). Interpretative Phenomenological Analysis: theory, method and research. London: Sage.

Smith, J. A., & Shinebourne, P. (2012). Interpretative phenomenological analysis. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf & K. J. Sher (Eds.), APA handbook of research methods in psychology, Vol 2: Research designs: Quantitative, qualitative, neuropsychological, and biological (pp. 73-82). Washington, DC, US: American Psychological Association.

Spector, P. E., & O'Connell, B. J. (1994). The contribution of personality traits, negative affectivity, locus of control and Type A to the subsequent reports of jobs stressors and job strains. Journal of Occupational and Organizational Psychology, 6, 1-11.

Spettell, C. M., & Liebert, R. M. (1986). Training for safety in automated person-machine systems. American Psychologist, 41(5), 545-550.

Squire, L. R. (1992). Declarative and nondeclarative memory: multiple brain systems supporting learning and memory. Journal of Cognitive Neuroscience, 4(3), 232-243.

Stanton, N. A., & Salmon, P. M. (2009). Human error taxonomies applied to driving: A generic driver error taxonomy and its implications for intelligent transport systems. Safety Science, 47, 227-237.

Styles, E. (2006). The Psychology of Attention. Hove: Psychology Press.

Sudman, S., Bradburn, N. M., & Schwarz, N. (1996). Thinking about answers: the application of cognitive processes to survey methodology. San Francisco: Jossey-Bass Publishers.

Symonds, J. E., & Gorard, S. (2008). The death of mixed methods: research labels and their casualties. Paper presented at the BERA Annual Conference, Heriot Watt University, Edinburgh.

Teddlie, C., & Tashakkori, A. (2009). Foundations of mixed methods research: integrating quantitative and qualitative approaches in the social and behavioural sciences. Thousand Oaks (CA): Sage Publications, Inc.

Thomas, G. (2012). Community pharmacy services in Wales, 2011-12: NHS Wales Shared Services Partnership (Prescribing Services and Contractor Services).

TNS UK Ltd. (2011). Evaluation of the impact of the responsible pharmacist regulations   Retrieved 16.07.13, from http://www.rpharms.com/promoting-pharmacy-pdfs/responsiblepharmacistreport.pdf

Tranum, D., & Grasha, A. F. (2002). Susceptibility to illusions and cognitive style: implications for pharmacy dispensing. Perceptual and Motor Skills, 95, 1063-1086.

Treisman, A. M. (1960). Contextual cues in selective listening. Quarterly Journal of Experimental Psychology, 12, 242–248.

Treisman, A. M., & Davies, A. (1973). Divided attention to eye and ear. In S. Kornblum (Ed.), Attention and performance IV. New York: Academic Press.

Tsang, P. S., & Vidulich, M. A. (2006). Mental Workload and Situation Awareness Handbook of Human Factors and Ergonomics (pp. 243-268): John Wiley & Sons, Inc.

Tulving, E. (1972). Episodic and semantic memory. In E. Tulving & W. Donaldson (Eds.), Organization of memory. Oxford: Academic Press.

Upton, D. (2003). Double checking: does it work. Canadian Journal of Hospital Pharmacy, 56(3), 167-169.

van Beuzekom, M., Boer, F., Akerboom, S., & Hudson, P. (2012). Patient safety in the operating room: an intervention study on latent risk factors. BMC Surgery, 12(1), 10.

Van Merriënboer, J. J. G., & Sweller, J. (2010). Cognitive load theory in health professional education: design principles and strategies. Medical Education, 44(1), 85-93. doi: 10.1111/j.1365-2923.2009.03498.x

van Someren, M. W., Barnard, Y. F., & Sandberg, J. A. C. (1994). The think aloud method: a practical guide to modelling cognitive processes. London: Academic Press.

Van Wert, M. J., Horowitz, T. S., & Wolfe, J. M. (2009). Even in correctable search, some types of rare targets are frequently missed. Attention, Perception and Psychophysics, 71(3), 541-553.

Welford, A. T. (1952). The psychological refractory period and the timing of high speed performance: A review and a theory. British Journal of Psychology, 43, 2-19.

Wickens, C. D. (1992). Engineering Psychology and Human Performance (2nd ed.). New York: Harper Collins.

Wickens, C. D. (2002). Multiple resources and performance prediction. Theoretical Issues in Ergonomics Science, 3(2), 159-177.

Wickens, C. D. (2008). Multiple resources and mental workload. Human Factors, 50(3), 449-455.

Wickens, C. D., Hollands, J. G., Banbury, S., & Parasuraman, R. (2013). Engineering psychology and human performance (international edition) (4th ed., pp. 8-48). Upper Saddle River (NJ): Pearson.

Wickens, C. D., Lee, J. D., Liu, Y., & Gordon Becker, S. E. (2004). An introduction to human factors engineering (2nd Ed). Upper Saddle River (NJ): Pearson Education.

Willig, C. (2001). Introducing qualitative research in psychology. Buckingham: Open University Press.

Willig, C. (2012). Perspectives on the epistemological bases for qualitative research. In H. Cooper (Ed.), APA handbook of research methods in psychology (Vol. 1. Foundations, planning, measures and psychometrics, pp. 5-21). Washington DC, US: American Psychological Association.

Witkin, H. A., Moore, C. A., Goodenough, D. R., & Cox, P. W. (1977). Field-Dependent and Field-Independent Cognitive Styles and Their Educational Implications. Review of Educational Research, 47(1), 1-64. doi: 10.2307/1169967

Wolfe, J. M., Horowitz, T. S., & Kenner, N. M. (2005). Rare items often missed in visual search. Nature 435, 439.

Wolfe, J. M., Horowitz, T. S., Van Wert, M. J., Kenner, N. M., Place, S. S., & Kibbi, N. (2007). Low target prevalence is a stubborn source of errors in visual search tasks. Journal of Experimental Psychology: General, 136(4), 623-638.

Xie, B., & Salvendy, G. (2000). Review and reappraisal of modelling and predicting mental workload in single- and multi-task environments. Work and Stress, 14(1), 74-99.

Yerkes, R. M., & Dodson, J. D. (1908). The relation of strength of stimulus to rapidity of habit-formation. Journal of Comparative Neurology and Psychology, 18, 459-482.

Appendix 1: Think aloud coding protocols

Following the verbatim transcription of think aloud recordings. The transcripts (or think aloud protocols) are examined and coded for the following issues.

1. **Coding for comprehension issues**

    The first thing that needs to be found out is simply whether the respondent has interpreted the questionnaire item in the way it was intended. This involves reading the transcripts to identify where:

    a) the respondent requests clarification or says things like "I don't know what that means (code as respondent needs more information)
    b) The respondent has misunderstood the question without realising

    This comprehension coding process was adapted from Cannell, Fowler & Marquis (1968).

2. **Coding for retrieval issues**

    Using Bolton's (1991) coding scheme (parts 2 and 3 only) reproduced below the transcripts were read for incidences where the respondent said (for example) "I don't remember." Whilst coding for these issues, another, unexpected retrieval issue was identified and so a new code was created ("question biased"), to represent issues where answers to earlier questions biased answers to the later questions.

    Bolton's (1991) coding scheme for retrieval issues (parts 2 and 3 only):

    Retrieval: No experience
    No: experience
    Never: experience(d)
    Not: experience(d)
    Any: experience
    Haven't: experienced
    Not: familiar: with
    Never: done

    Retrieval: don't remember
    Don't: remember
    Forget

Can't: think
I'm: trying: to: think
Or: something

3. **Coding for judgement issues**

    Complex coding schedules for judgement issues have been developed, for example Sudman et al (1996). A simple procedure was used for this study, which was developed for this project by HF. Based on the theories behind retrieval issues (see Sudman et al, 1996 or Collins, 2003) the protocols were screened for instances where it was obvious that the design of the response categories was affecting the response given (e.g. participant says: 'I am not sure which to put, often or sometimes?' when answering a frequency rating scale). The think aloud transcripts were also screened for comments which suggested the participant may not be sure whether the information they had retrieved from their memory was correct. Or where the transcripts indicated that they were not aware that the information they had retrieved was incorrect (i.e. their response was made using irrelevant or inappropriate information).

4. **Coding for response issues**

    Transcripts were also examined and coded for instances where participants verbally noted altering of their response to give a more socially desirable response. Some participants explicitly commented on this, but long pauses and where participants changed their minds about a response choice several times were also noted as potential indicators of response issues (see Sudman et al, 1996 for a review of the literature on socially desirable responses).

Appendix 2: Interview Topic Guide

Introduction

The aim of today is to learn more about your experiences of mental workload at work and how they relate to the work you were asked to do when you came to the University of Bath to take part in the experiment. (**CPs only:** You have also completed a mental workload diary over a day whilst you were at work so we will start by talking about that and find out how typical that day at work was compared to normal).

Pharmacy students were not asked the questions under section 1 or 2 of this topic guide.

1. **About the Mental Workload diary**
   - So to start off how did you find completing the mental workload diary?
   - [other questions based on the scores they have given in the diary – e.g. very high mental effort scores, or frustration scores – to find out why they felt that they were having to make lots of mental effort / felt frustrated etc]
   - When you felt your MW was high / low
     o How did you know that you felt like it was taking more or less effort (e.g. did your eyes feel tired, or did you have a headache or were you finding it hard to concentrate?)
     o was there anything that you did to try and relieve that feeling?
     o Did you feel like it was affecting how you did your work?
       ▪ If yes – did you feel like there was anything you could do to stop it affecting your work?

2. **About that day at work when you completed the mental workload diary**
   - What was work like that day?
     o Prompts:
       ▪ Was it busier / quieter than normal?
       ▪ How did you feel about having to be at work that day?
       ▪ How did you feel about having to complete the mw diary?
       ▪ Did anything else unusual happen that day?

3. **Experiences of accuracy checking**
   - How did you find the accuracy checking task?

- ○ Prompts:
  - What was it like compared to the accuracy checking you do at work?
  - Was it more or less challenging than when you are at work?
    - what made it more challenging (e.g. environment, colleagues, amount of work etc)?
    - what made it less challenging (e.g. environment, colleagues, amount of work etc)?
  - Do you have a set way of accuracy checking?
    - Does that make the task easier or harder?
    - Was this a routine you were taught or did you come up with it yourself?

- Have you ever missed a dispensing error when you were doing an accuracy check task at work?
  - ○ Prompts:
    - Did you know why you had missed it?
    - How did that make you feel?
    - How did you feel the next time you did the same task?

4. **Other things on your mind**
   - **Do you ever come to class / go to work and find your mind is on other things?**
   <e.g. row with significant other - worries about up-coming deadlines>
     - ○ Prompts:
       - How do you cope with those times?
       - Do you think it impacts on your work?
         - Why?
         -
5. **Defining mental workload**
   - **I wanted to give you the definition of mental workload that researchers use and I wondered if you thought it was right? So MW can be defined as the load that performing a task imposes on an individual's mental processes and is the result of the interaction between an individuals' characteristics, the features of the task and the environment.**
     - ○ **Prompt:**
       - Does that sound right to you?
       - Was that how you felt?
         - What was right about this definition?
         - What was wrong with this definition?

6. **So we've come to the end of my formal questions now, but before we finish I wanted to ask you if there was anything that you think is important to this topic that I haven't asked about?**

Appendix 3: Questionnaires

Dundee Stress State Questionnaire

The Dundee Stress State Questionnaire (DSSQ;Matthews et al., 2002; Matthews et al., 1999) is comprised of 96 items, which is split into 5 questionnaires with 13 subscales. The questionnaire assesses 11 primary dimensions of mood, motivation, and cognition in performance settings (Matthews et al., 2006).

The author of this questionnaire has given their permission for descriptions of the scales and example items from each scale to be included in the appendix of this report (see Table A1 below). To obtain a full-copy of the DSSQ the author, Professor Gerald Matthews can be contacted at the University of Central Florida, Institute for Simulation and Training, ACTIVE Lab, Partnership II Building, 3100 Technology Parkway, Orlando, FL 32826 USA. Telephone: 407-882-0119 or e-mail: gmatthew@ist.ucf.edu.

Table A1: The five DSSQ questionnaires and the 13 subscales with definitions

DSSQ scales and subscales	Subscale description
Mood states	The mood scale used in the DSSQ is the UWIST Mood Adjective Checklist (Matthews, Jones, & Chamberlain, 1990). Participants are given a list of 29 words which describe people's moods or feelings and are asked to indicate how well each word describes how they felt at the beginning of the study (administration 1) and during the task (administrations 2 and 3). Each item is scored on a 4-point scale that ranges from 1- "definitely" to 4 – "definitely not." For each word, participants are asked to circle the answer from 1 to 4 which best describes their mood.
Energetic Arousal	Measures moods ranging from feeling sleepy to awake. The subscale is scored out of 32 and higher scores equal feeling awake. *Example item: Alert?*
Tense Arousal	Measures moods ranging from feeling calm to nervous. This subscale is also scored out of 32 with higher scores representing greater feelings of calm. *Example item: Relaxed?*
Hedonic Tone	Measures mood states ranging from positive to negative, scored out of 32 and higher scores represent a more positive mood. *Example item: Happy?*
Anger / Frustration	Measures levels of anger and frustration, this scale is scored out of 20 and high scores equate to higher levels of anger and frustration. *Example item: Impatient?*
Motivation	The motivation subscale was written specifically for the DSSQ. Participants are asked to rate their attitude towards the task they are about to complete (administration 1)/ have just completed (administrations 2 and 3). Participants rate their agreement with each item on a 4-point scale ranging from 0 - "Not at all" to 4 - "Extremely."
Intrinsic Motivation	Intrinsic motivation refers to interest in the task. This scale is scored out of 28, high scores represent high levels of intrinsic motivation. *Example item: "The only reason to do the task is to get an external reward (e.g. payment)."*
Success Motivation	Success motivation refers to the motivation to excel in performance and at the task, this subscale is scored out of 28 and higher scores equal higher levels of success motivation. *Example item: "I was eager to do well"*
Overall Motivation	This is scored out of 4 and a higher score reflects higher levels of overall motivation. *Example item: "I was motivated to do the task."*

Table A1 continued: The five DSSQ questionnaires and the 13 subscales with definitions

DSSQ scales and subscales	Subscale description
Thinking Style	This is the third part of the DSSQ and it measures current mental states, this scale includes modified version of a measure of private self-consciousness or self-focus (Fenigstein, Scheier, & Buss, 1975). It also includes items from Heatherton and Polivy's (1991) self-esteem scales. As well as new items on concentration and perceived control. On this scale participants are asked to rate their style of thinking (including thoughts about themselves, how their mind is working, how confident they are in the task and how well they believe they performed) during the task. Participants rate their agreement with each statement on a scale of 0-"not at all" to 4 – "extremely."
Self-focussed Attention	Self-focussed attention is thought to increase when an individual is experiencing states of stress. There are 8 items measuring self-focussed attention meaning this subscale is scored out of a total of 32. High scores equal high levels of stress. *Example item: "I attended to my inner feelings"*
Self-esteem	This measures participants' self-esteem (in the moment rather than in general). There are seven items measuring self-esteem and this sub-scale is scored out of 28 and high scores indicate high self-esteem. *Example item: "I was concerned about the impression I was making."*
Control and confidence	This subscale also captures some aspects of self-esteem, but also perceived control within the task environment. This sub-scale has seven items and is scored out of 28. High scores equal high levels of control and confidence. *Example item: "I performed proficiently on this task."*
Concentration	This subscale measures current levels of perceived concentration or attention, it has seven items and is scored out of 28. High scores represent good concentration. *Example item: "My mind wandered a great deal."*
Thinking Content	This is the fourth part of the questionnaire and it measures mental interference (concerning the types of thoughts that go through people's heads when they undertake a task), it is comprised of 16 items from the Cognitive Interference Questionnaire (Sarason, Sarason, Keefe, Hayes, & Shearin, 1986). Participants are asked to rate their agreement with a series of 16 statements about the types of thoughts they may have had in the last 10 minutes. Participants rate their agreement on a 5-point scale ranging from 1 - "Never" to 5 - "very often."
Task-relevant interference	Measures how much participants are thinking about the task, in particular their performance of the task and why they are being asked to do the task. There are eight items on this sub-scale, scored out of 40, high scores on this scale may reflect a level of fear or worry over their performance on the task. *Example item: "I thought about how much time I had left."*
Task-irrelevant interference	Measures how much participants are thinking about other things, for example what is going on in their lives. Also scored out of 40, high scores indicate a high level of task-irrelevant interference. *Example item: "I thought about personal worries."*

NASA Task Load Index

In this study a modified version of the NASA Task Load Index (NASA-TLX; Hart, 2006; Hart & Staveland, 1988) which forms part of the DSSQ was used. The DSSQ version of the NASA-TLX measures the MWL experienced by participants during the task on 6 dimensions, each scored on an 11 point visual-analogue scale ranging from 0-"low" to 10-"high." The original NASA-TLX is measured on a 21 point visual analogue scale ranging from "low" to "high" for five of the items, the sixth item, measuring "performance" is measured on a 21 point visual analogue scale ranging from "good" to "poor." In the DSSQ version of the scale, all six items are rated on the same scale but scores on the performance items are reversed before analysis.

The six dimensions by the NASA-TLX are: mental demand, physical demand, effort, (task) frustration, performance concern and temporal demand (time pressure). Each item can be analysed separately and an overall score is produced (from the mean of the six item scores), to give an overall level of MWL (which is scored between 0-10) (Hart, 2006; Hart & Staveland, 1988). The questionnaire items are re-produced in Figure A.1 below.

The original NASA-TLX scale and administration manual can be downloaded from this website:

http://humansystems.arc.nasa.gov/groups/tlx/

Please rate the MENTAL DEMAND of the task: How much mental and perceptual activity was required?

Low	0	1	2	3	4	5	6	7	8	9	10	High

Please rate the PHYSICAL DEMAND of the task: How much physical activity was required?

Low	0	1	2	3	4	5	6	7	8	9	10	High

Please rate the TEMPORAL DEMAND of the task: How much time pressure did you feel due to the pace at which the task elements occurred?

Low	0	1	2	3	4	5	6	7	8	9	10	High

Please rate your PERFORMANCE: How successful do you think you were in accomplishing the goals of the task?

Low	0	1	2	3	4	5	6	7	8	9	10	High

Please rate your EFFORT: How hard did you have to work (mentally and physically) to accomplish your level of performance?

Low	0	1	2	3	4	5	6	7	8	9	10	High

Please rate your FRUSTRATION: How discouraged, irritated, stressed and annoyed did you feel during the task?

Low	0	1	2	3	4	5	6	7	8	9	10	High

Figure A1: Modified NASA-TLX mental workload measure from the DSSQ scale

Big Five Personality Index

Personality traits were measured using the Big Five Inventory (Benet-Martinez & John, 1998; John, Donahue, & Kentle, 1991; John, Naumann, & Soto, 2008). The scale has 44 items rated on a five point scale where '1' indicates that a participant 'strongly disagrees' with a statement and '5' indicates they 'strongly agree' with a statement. Scores were reversed and then summarised (the mean score of all the items which relate to each trait, giving a maximum score of 5 for each trait) according to the BFI instructions, this produced five summary scores reflecting the five dimensions of personality (these traits are outlined in Table A2 below).

A full copy of the questionnaire can be requested and downloaded from the authors' website, for more details please visit: http://www.ocf.berkeley.edu/~johnlab/bfi.htm.

Table A2: The Big Five Personality Traits and example questionnaire items

Big Five Personality Trait	Trait description
Openness to experience	Assesses proactive seeking and appreciation of experience. An interest in exploration of the unfamiliar. Those who score highly on this trait are curious, creative, imaginative, un-traditional and have broad interests. Those who score low on this scale tend to be more conventional, down-to-earth, not artistic or analytical. *Example item:* "*Has few artistic interests.*"
Conscientiousness	Assesses the individual's level of organization, persistence and motivation in goal directed behaviour. Highly conscientious people are reliable, hard-working, self-disciplined and punctual. Those who score low on this trait tend to be aimless, unreliable, lazy, weak-willed and hedonistic. *Example item:* "*Tends to be disorganized.*"
Extraversion	Assesses the quantity and intensity of interpersonal interaction, activity levels, need for stimulation and capacity for joy. A person who scores high on trait extraversion may, for example be a more sociable, active, talkative, person orientated and optimistic compared to someone who scores low on this trait who would be described as more reserved, aloof, un-exuberant, quiet and task oriented. *Example item:* "*Is reserved.*"
Agreeableness	Assesses the quality of one's interpersonal interactions. Those who score high on this trait are soft-hearted, good natured, trusting, helpful and those who score low on this trait are cynical, rude and uncooperative. *Example item:* "*Starts quarrels with others.*"
Neuroticism	Assesses emotional stability. A person who scores highly on trait neuroticism may, for example, tend to worry more, be more nervous and experience more feelings of insecurity compared to most, by comparison those who score low on trait neuroticism tend to be calm, relaxed, less emotional and secure. *Example item:* "*Remains calm in tense situations.*"

Table adapted from Pervin and John (2001, Table 8.1, p.25)

Mental Workload Diary

The mental workload diary included 7 copies of the NASA-TLX scale (the modified version used in the DSSQ). At the top of each NASA-TLX scale in the diary, participants were asked to report the time and date of the rating and rate the "busyness of the pharmacy" on the same scale as the NASA-TLX items. Before the mental workload ratings participants were asked to complete some demographic information about themselves and their pharmacy. These demographic questions were designed for the purposes of this study. The MWL diary instructions, the demographics questions and the first page of the NASA-TLX rating

scale in the diary are reproduced on pages 338 to 341 below (the other six NASA-TLX rating scales in the diary were identical to the ones reproduced below).

Instructions

1. Please complete this mental workload diary **on the day of your choice.**

2. We need you to complete a mental workload rating (questions 1-7) a **minimum of TWO times,** and if possible, for:
   - one set of mental workload ratings to be done at a **quiet time** in your pharmacy,
   - one set of mental workload ratings to be done at a **busy time** in your pharmacy.

3. We have left you space to complete **up to 7** mental workload ratings, if you are going to do this many please do **(approximately) one per hour of work.** Do not worry if you forget for a while when you do remember just complete one then (one rating every hour is just a guide).

4. Please **complete the information about yourself and the pharmacy** at the beginning of the workload diary.

5. Each time you do a mental workload rating please answer **every** question, even if you find it difficult.

6. Answer, as honestly as you can, what is true of **you.**

7. Please do not choose a reply just because it seems like the 'right thing to say'.

8. Your answers will be kept entirely **confidential** and **anonymous** and will not be shared with your employer or anyone else outside the research project.

9. Also, be sure to answer according to how you feel **AT THE MOMENT**. Don't just put down how you usually feel.

10. You should try and work quite quickly: there is no need to think very hard about the answers. The first answer you think of is usually the best.

Please return this diary in the stamped address envelope provided.

Thank you again for all your support of this project,

About you

1. Are you Male or Female?

☐ Male
☐ Female

2. How many hours do you work?

☐ Full-time (37.5hours a week)
☐ Part-time (Please specify approx. hours a week: ____)

3. How many hours do you work per shift?

☐ <2 Hours
☐ 3 Hours
☐ 4 Hours
☐ 5 Hours
☐ 6 Hours

4. How long have you been a qualified pharmacist?

☐ <2 Years
☐ 2-5 Years
☐ 6-10 Years
☐ 11-20 Years
☐ 21-30 Years
☐ 31-40 Years
☐ 40+ Years

About your Pharmacy

5. Where is the pharmacy located at?

☐ City Centre
☐ Town Centre
☐ Village
☐ Other (Please Specify: _____)

6. What type of pharmacy is it?

- ☐ Health Centre
- ☐ High Street Multiple
- ☐ Supermarket
- ☐ '100-hour Pharmacy'
- ☐ Other (Please Specify: _____)

7.　　What is the Maximum number of pharmacists working at one time?

- ☐ 1
- ☐ 2
- ☐ >3

8.　　What is the number of dispensary staff (other than pharmacists) working at one time?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ >5

9. How many items are dispensed daily approximately?

- ☐ <50
- ☐ 50–150
- ☐ 150–250
- ☐ 250–350
- ☐ >350

10. What advanced and enhanced services do you provide?

Advanced
- ☐ Medicines Use Review
- ☐ Appliance Use Review
- ☐ Stoma Appliance Customisation
- ☐ New Medicine Service

Enhanced
- ☐ Needle & Syringe Exchange
- ☐ Smoking Cessation
- ☐ Minor Ailment Service
- ☐ Emergency Hormonal Contraception
- ☐ Other (Please Specify: _____)

Mental Workload Rating 1

Date today: ____/____/2012   Time of day now: _____

1. On a scale of 0 to 10 how busy would you describe your pharmacy at the moment?

Very   0   1   2   3   4   5   6   7   8   9   10   Very
Quiet   Busy

2. Please rate the MENTAL DEMAND of the task: How much mental and perceptual
activity was required?
Low   0   1   2   3   4   5   6   7   8   9   10   High

3. Please rate the PHYSICAL DEMAND of the task: How much physical activity was
required?
Low   0   1   2   3   4   5   6   7   8   9   10   High

4. Please rate the TEMPORAL DEMAND of the task: How much time pressure did you feel
due to the pace at which the task elements occurred?
Low   0   1   2   3   4   5   6   7   8   9   10   High

5. Please rate your PERFORMANCE: How successful do you think you were in
accomplishing the goals of the task?
Low   0   1   2   3   4   5   6   7   8   9   10   High

6. Please rate your EFFORT: How hard did you have to work (mentally and physically) to
accomplish your level of performance?
Low   0   1   2   3   4   5   6   7   8   9   10   High

7. Please rate your FRUSTRATION: How discouraged, irritated, stressed and annoyed did
you feel during the task?
Low   0   1   2   3   4   5   6   7   8   9   10   High

Appendix 4: Definitions of the Superordinate and Emergent Themes

Table A3: Definitions of the superordinate and emergent themes identified in the qualitative analysis

Super-ordinate themes & definition	Emergent themes	Emergent theme definitions
Students' experiences of working in a pharmacy This theme summarises experiences that are unique to pharmacy students, and the differences they perceive between these two settings	Missing the basics	Students felt that the errors they made when dispensing were often the result of missing the basics, things they felt they already knew, but in that moment forgot to implement.
	Spanner in the works	Used to describe times when new information (e.g. a new drug) was encountered by a student pharmacist and they felt that this led to missing the basics (e.g. forgetting a stage of their usual dispensing process).
	University vs. real-life dispensing	Students often compared practice in the simulated pharmacy with their experiences of real-life dispensing. For example many students felt that dispensing in real-life was less stressful than practice at university because they were being marked on their performance at university.
	The pressure of the counter	This theme codes instances where students reported finding working on the pharmacy counter (where the tills are, and where the over the counter medicines may be sold) as this required them to be able to remember and correctly communicate information about medicines to patients. Away from the counter, there was less immediate pressure on this knowledge.
	(Time for) Reflection on performance	This codes aspects of students' narratives about not having time at university or in real-life pharmacy practice to reflect on their performance. So often they thought about their performance on the way home from work or university.
The role of the	Community	This theme captures community pharmacists and student pharmacists position on

community pharmacist This theme summarises pharmacy students and community pharmacists' perception of the role of the pharmacist, the pressures that come with the various additional roles and the management of pharmacists.	pharmacists' role	what the community pharmacist role should entail, how they feel about their current role, and how they feel it has changed in recent years. For students and CPs alike narratives also included concerns over career progression (or lack thereof).
	Juggling the role of pharmacist and manager	This theme captures the pressures that community pharmacists with this dual role experienced, the compatibility of the two roles, and unique strategies they used to manage the pressures of this role.
	Non-pharmacy managers	Students and community pharmacists highlighted issues caused through working with non-pharmacy managers – in particular a lack of awareness on the pharmacy managers' part about the laws and regulations pharmacists are expected to work within. CPs and students reported a perception that their focus was only on meeting commercial targets, not on patient care.
	Training (others)	Pharmacists reported feeling both personal and professional responsibility to train less senior members of staff (pre-registration pharmacists, pharmacy support staff). They also expressed concerns that the time and the staffing levels made this difficult to achieve.
	Job-satisfaction	This theme captured aspects of community pharmacists and pharmacy students narratives that explored the times when they felt they experienced job satisfaction in their role, as well as the times that led to reduced job satisfaction.
Sources of frustration This theme explores the factors which were a source of frustration in their day to day work	No control	In describing community pharmacy workload all participants spoke about the lack of control over the workload, in particular the peaks and troughs in workload. For many this was a daily source of frustration with their work.
	Taking breaks	Many pharmacists reported being unable to take breaks and this theme captures quotes around this and the impact this has on patient safety and how this made them feel.
	Communication issues	Students and Pharmacists reported issues in communicating with other healthcare professionals and with patients.
	Task frustration	Pharmacists and students' task frustrations with commercial targets, e.g. mystery

		shoppers, the dispensary e.g. messy dispensaries, and procedures were captured by this theme.
	Frustration with the profession	This theme relates to the frustrations pharmacists and pharmacy students reported in relation to their role and profession, the impact they had on patient care and how they are viewed by patients and other healthcare professionals.
Impact of the pharmacist on the patients' experience This theme explores the importance and value pharmacists place on the impact they have on patient care, and patients experiences in pharmacies	Pressure to meet patients' expectations	Pharmacists and students spoke about the expectations of patients (e.g. around waiting times) and a lack of public knowledge on the role of pharmacists, what they were legally required to do (and couldn't do) and this was captured by this theme.
	The personal touch	For pharmacists who worked in an independent pharmacy, or owned a pharmacy, the personal touch was of great importance, in particular in sustaining business (over bigger chains). However this was something that these pharmacists felt their workload no longer allowed for.
	Continuity of care	Many pharmacists felt continuity of care was particularly important. Locum pharmacists were not able to provide this continuity, however in some pharmacies the patient medication record was seen as a vital tool to maintain continuity of care and also patient safety. This theme captures aspects of participants narratives where they discussed the continuity of patients' care.
	Weighing up	Both groups of participants spoke about constantly weighing pressures – e.g. best practice vs patient satisfaction; cost (making a loss) vs patient need.
Working with others in the pharmacy This theme encompasses issues around staffing levels, locum staff and co-worker satisfaction	Co-workers	This emergent theme captured issues around understaffing, co-worker satisfaction, the need to work as a team to be able to manage the workload. This theme also captured the professional isolation that those who did not work with a second pharmacist felt in their role.
	Locums	This theme related to quotes around the limitations regular pharmacists and student pharmacists felt when working with locum staff, as well as the limitations that locum pharmacists perceived in their role. The procedural and interpersonal mechanisms that supported locum pharmacists' integration into the team were also

and how they relate to experiences of workload.		captured by this theme.
The development of expertise This theme explores the experiences of novice vs expert pharmacists, what expertise teaches pharmacists, and how pharmacists keep up to date.	Expertise	This theme related to aspects of the narratives where participants talked about the expertise they felt they had gained in their role, and for students times when they became aware of their own lack of expertise.
	Knowledge	For student pharmacists, the development of expertise was focused around knowledge.
	Knowing limits	For community pharmacists expertise meant knowing their limits and when they weren't able to do any more, and when they needed to take a break. This theme also captured pharmacists' reflections on their work as a pharmacist before they had learnt their own limits.
	Keeping up-to-date	Both student and community pharmacists spoke about the pressures and difficulty of keeping up to date, the ways they tried to keep up to date, and the consequences of not keeping up to date.
Sources of pressure This theme explores the multiple sources of pressures and the impacts this has on pharmacists work, their mental workload and other mood states.	Objective workload	Pharmacists descriptions of the amount of work they have including the use of metaphors e.g. "dispensing treadmill" which capture the routine nature of many aspects of their work.
	Time pressure	Time pressure captured aspects of pharmacists and student pharmacists' narratives where they spoke about not having enough time to – for example, take a comfort break or counsel patients about their medicines in detail, or carry out audits, or train staff. This theme also covered time pressure caused by other members of staff, through carrying out enhanced and advanced services (causing a queue of patients waiting for their medicines), time pressure imposed by patients and the opening hours of the pharmacy.
	Commercial pressures	This theme relates to times when pharmacists and student pharmacists spoke about their experiences of working to NHS targets, and company targets and the impact this had on the pace of their work and how they felt about their work,

		organisation and role.
	Enhanced and advanced services	Enhanced and advanced services caused time pressure, and were related to commercial targets, but were also a source of pressure due to the difficulty in identifying patients who would fit the criteria for these services, and would benefit from these services. This theme captures this and similar pressures.
	Responsibility	Pharmacists spoke about the high level of responsibility they felt in their role, towards junior members of staff, towards their organisation and towards patients. This theme also captures pharmacists' reports relating to the responsible pharmacist regulations, and the confusion of individual and corporate responsibility in these regulations.
	Multi-tasking	Both student and community pharmacists reported the requirement to multi-task constantly throughout the day as a significant pressure. Multitasking occurred naturally due to the hustle and bustle of the stores, but because pharmacists felt they needed to monitor the work being done by other members of staff e.g. listening to advice given on the counter by more junior members of staff whilst at the same time carrying out their own safety critical tasks.
	Other mood states	This theme captured pharmacists' and students descriptions of the impact these pressures have on their mood states (e.g. through causing anxiety, despondency). This theme also identifies comments by participants about the interference caused by task related anxieties or thoughts whilst they were carrying their work, and the feeling that in a small work environment moods of other staff "rub-off" also causing a distraction to their work.
Coping with pressure This theme explores how expert and novice pharmacists cope with the pressures in their	Organising workload	This theme captures comments by pharmacists and students around how they organise, prioritise and manage their high workload.
	Busy times	This theme captures pharmacists and pharmacy student's descriptions of what busy times are like, how their work changes at these times, how their mental states and moods change at this time.
	In the back of	This theme describes participant's narratives about the to-do lists they carry in

work, the feeling of pressure in the back of their heads, difficulty they have and the level of mental focussed required to keep on top of their work.	my head	their heads during the day, and the pressures they experience at work which are "in the back of their head" at work, and later when they go home.
	In the zone	This theme describe pharmacists and pharmacy student's reports of needing to be mentally focussed or "in the zone" to be able to carry out their work safely. Participants report difficulty getting into the zone at the beginning of a shift, and after a break or holiday and how at these times they feel more susceptible to making errors.
Experiences of mental workload This theme explores the different aspects of mental workload in a pharmacy context through the experiences and descriptions of pharmacists and pharmacy students.	What mental workload feels like	This theme relates to pharmacists and pharmacy students' descriptions of mental workload, and how it feels for them.
	Physical impact of mental workload	Participants also described the impact that mental workload has on their energy levels physically and mentally, including experiences of raised heart-rates.
	Sources of Mental workload	This theme relates to the sources pharmacists and pharmacy students perceive as increasing or decreasing their mental workload.
	Physical demands of pharmacy work	This theme captures participants' perceptions of the physical demands involved in pharmacy work and how this varies between pharmacy organisations and how this impacts on other aspects of their work.
	Mental demands of pharmacy work	This theme captured experiences of both mental overload and underload, and the mental and perceptual work required to carry out pharmacy work.
	Performance concerns	This theme relates how pharmacists measured their own performance (e.g. through how far they had got down their to-do list) and how their organisation measured their performance. Pharmacy students and community pharmacists both spoke about performance concerns which occurred on a daily basis.
	Personal vs. work life	This theme captured pharmacists' concerns over taking work home with them, and the importance of having time to switch off. It also captured students and

		pharmacists experiences of their personal lives at time being a distraction when at work.
The importance of distraction This theme explores the role distraction plays in creating pharmacy errors, the types of distractions that occur and the distractions caused by patients.	Distractions	This theme captured all participants reports of distractions, the common distractions (e.g. telephones), how they managed distractions (e.g. removing telephones from the dispensary) and the impact distractions had on their work (e.g. increased time to complete work) and their mind-set.
	Having patients' eyes on you	This was particular to some pharmacy chains where dispensing is carried out at the front of the pharmacy in front of patients. Pharmacists and students described this experience as adding time pressure, but also a distraction to their work as they could feel the patients' eyes on them as they were dispensing their medicine.
Dispensing errors This theme explores how dispensing errors occur in pharmacists and pharmacy students' experience. The value of checking to prevent errors and the impact of the pharmacy setting and dispensary layout on the occurrence of errors.	Dispensing errors	Pharmacy students' and pharmacists' descriptions of times when they made a dispensing error, or had been involved in one and the factors they felt caused it, including the context surrounding these incidents. This theme also covers factors which pharmacists and pharmacy students felt made them more susceptible to making errors.
	Checking	This theme captured aspects of participants' checking process, times when they have missed an error on checking and why, reflections on whether the process they used in practice was different to the one they used in the experiments in this study, their thoughts on the value of checking and the member of the pharmacy team best placed to carry out checks (e.g. ACT or pharmacist).
	The pharmacy set-up	Pharmacist and pharmacy students' discussions of the impact of the dispensary layout and the setting of the pharmacy (e.g. part of a larger store vs. dedicated pharmacy store) on dispensing errors.