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'Smoking to Forget': The Impact of Prolonged Smoking on Prospective Memory

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ABSTRACT

Prospective memory (PM) refers to remembering to remember and is essential for everyday living. Although recent research has focused upon PM deficits associated with recreational drug use, very little research to date has focused on smoking and PM. This thesis had four aims. Firstly, to verify whether PM deficits are associated with prolonged smoking could be replicated. Secondly, to observe whether such smoking-related deficits extended to objective measures of PM. Thirdly, to assess what effect, if any, abstinence from smoking had upon PM. Fourthly, to ascertain whether there was any difference in PM performance between regular (daily) smokers and social (binge) smokers. Participants were drawn primarily from undergraduates in North East universities. Studies 1–3 in this thesis studied self-reports and objective measures of PM in smokers, previous smokers and non-smokers. Across all three studies no consistent findings were observed on self-reported PM reflecting deficits associated with smoking, but smokers performed worse on the objective measures of PM than non-smokers, with previous smokers falling between the other two groups – suggesting that smokers' PM is impaired and that those who stopped smoking appeared to recover a proportion of their PM function. Study 4 revealed smokers' poor performance on objective tasks was not confounded by their being in a state of withdrawal. Studies 5 and 6 explored whether any difference was observed between 'social' (binge) smokers and 'regular' (daily) smokers on PM performance. Studies 5 and 6 found no difference between social and regular smokers on a video-based, nor a real-world PM task. Overall, it was concluded that self-reports of PM do not provide consistent findings (first aim),

lowered PM performance on objective measures are associated with prolonged smoking (second aim), previous smokers show some recovery of PM function (third aim) and that the pattern of smoking does not affect PM performance in smokers' (fourth aim).

CONTENTS   PAGE

LIST OF TABLES AND FIGURES

Tables   Page

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DECLARATION

I declare that the work contained in this thesis has not been submitted for any other award and that this is all my own work.

Name: Terence Stewart O'Neill

Signature:

Date:

PREFACE

Prospective memory (PM) refers to remembering to carry out specific intentions at some future point in time (McDaniel & Einstein, 2007). PM plays a crucial role in everyday life, for example, remembering to meet with friends at some future point in time and place, remembering to post a letter on time, pay one's bills on time, and so on. Forgetting intended plans can have a multitude of effects. Forgetting to meet with your friends on time can cause embarrassment, forgetting to take your medication can affect your personal health and safety, whereas forgetting to carry out a crucial set of manoeuvres whilst driving a car can have disastrous consequences. In the last 20 years the study of PM has grown enormously and is currently a worldwide focus for research and practical aspects of remembering. Recently PM has become the focus of research into what effects recreational drug use has upon remembering within an everyday context (Kliegel, McDaniel & Einstein, 2008). Current research has focused on the detrimental impact of alcohol misuse, cannabis and ecstasy upon PM (Kliegel et al., 2008). Much less is known about what impact smoking tobacco might have upon PM. Since smoking is pervasive throughout societies all around the world, it is important to forge a greater understanding of what impact prolonged smoking might have upon the psychological functioning. Smoking is known to be detrimental to the health of the individual however the impact of smoking upon ones cognition and PM in particular, has been largely overlooked by the psychological researchers connected with substance abuses. The present thesis attempts to elucidate the association between prolonged smoking and PM utilising a range of PM techniques. It will also consider what impact smoking cessation has upon PM functioning.

CHAPTER 1: Introduction and Background

1.0 Historical aspects of smoking

Although historically smoking was on the decline between 1970s and 1980s, it reached a plateau during 1994 until around 2000, after which it resumed a slow general decline (General Household Survey (GHS), 2007). By 2007 in the UK, 22 per cent of men and 20 per cent of women were smokers (GHS, 2007). Smoking is currently one of the most popular recreational drugs used in the U.K, along with alcohol use.

There is a large body of literature (summarised in the following sections) on the physiological, pharmacological and psychological consequences of smoking. Recently, research has focused on the consequences of recreational drug use and its impact upon behaviour and cognition (Parrott, Morinan, Moss & Scholey, 2004). In this respect, the present thesis aimed to increase our understanding of the cognitive consequences of persistent smoking, particularly within an everyday context where putative deficits are likely to have the greatest impact. Prospective memory (PM) is a good example of everyday memory (Kliegel, McDaniel & Einstein, 2008) and is the focus of the present thesis. The main aims of this thesis was to observe whether any PM deficits were evident in persistent smokers, utilising self-report and objective measures of PM and to observe whether cessation from smoking had an impact upon PM.   Finally the thesis aimed to consider whether specific patterns of smoking have a differential impact upon PM, in this case a comparison of social and regular smoking.

1.1: Smoking: Physiological, Pharmacological and Psychological Sequelae

1.1.1: Physiological Effects

"The humble cigarette is responsible for a dozen times more deaths in the UK in the past 40 years than British casualties from World War II – over 5 million." (Royal College of Physicians (R.C.of P.) 2007). A link between various health issues and tobacco smoking was established in the 1950's. Smoking has been found to be associated with a range of cancers, respiratory complications and coronary heart disease (Mannino & Buist, 2007). Health professionals now regard habitual smoking as a psychological addiction that is believed to lead to serious health and cognitive effects (World Health Organisation (WHO), 2004). In the 1960's, the British people were experiencing a period of lung cancer, heart disease and respiratory illnesses arising from high levels of post-World war II smoking and by the 1990's it was clear that smoking-related diseases such as cancer followed the course of smoking frequency. It had taken several decades for cancer to reveal itself over this period, but only a few years later for heart disease to do the same (R.C. of P., 2002).

In 1997-98, an estimated 364,000 hospital admissions in England were attributable to the diseases caused by smoking and accounted for over 7000 hospital admissions per week (i.e. 1000 per day). The admissions covered 109,000 from cancer, 112,000 from respiratory diseases other than lung cancer and 134,000 from various circulatory diseases. It, therefore, can clearly be seen that smoking has dangerous effects upon the health of some adults (R.C.of P., 2002). Current estimates for deaths caused by cigarette smoking suggest that around 130,000 deaths each year occur in the United Kingdom (Parrott, Morinan, Moss & Scholey, 2004). Cigarette smoking would certainly appear to shorten life expectancy.

Based on the UK 1997 death rates, it is possible to depict the reduction in life span for the individual smoker. Even those who reach the age of 65 years find that smoking can curtail expected lifespan by more than six years for men and 5.5 years for women. Those who have ceased smoking find that the figures fall closer to non-smokers than current smokers. Of those who smoke, one in four men aged 35, who continue to do so, can expect to die before the age of 65 compared to one in nine of non-smokers. The equivalent estimates for women are one in seven and one in twelve respectively. Overall, approximately one in every two smokers (i.e. 51% of males and 45% of females) will die prematurely as result of smoking.

One major organ affected by smoking is the heart. It has a large network of capillaries that are needed to supply the vast amounts of oxygen it needs. Smoking reduces this crucial supply and so may cause an ischemic heart ailment in the smoker. In addition, smoking increases circulatory maladies due to the tar and CO in the smoke and these are also known to generate other diseases such as cancers of the oesophagus, lungs, as well as pneumonia and emphysema. There are also a number of other health complications associated with smoking, e.g. sexual impotence and premature skin impairment (see Tengs and Osgood, 2001).

Clearly, from the above research, it can be seen that there are major fundamental effects on the health services from smoking-related illnesses and deaths. There can be two approaches used to estimate these types of cost to the NHS due to smoking in the1990's. They are:-

- by assigning the costs of all of the different diseases to smoking

- by estimating the health care costs of smokers compared to non-smokers.

Parrott and Garnham (1998) used both formats to estimate the annual smoking related costs in England at 1996/7 cost levels and found that the total estimated bill stood at £1.5 billion. The GHS estimates for the same period reached a comparable level of £1.4 billion. A breakdown of the different types of health service use estimated by this method are summarised for 1996/7 in the following:-

Table 1.1. Cost (in millions) smoking-related disease to NHS services.

Main Disease Group	Hospital Costs	Primary Care Cost	Pharmaceutical Cost in primary care	Totals
	£ millions	£ millions	£ millions	£ millions
Cancer	203	19	0*	222
Respiratory	273	72	0*	345
Circulatory	639	61	139	839
Digestive	100	4	0*	104
Totals	1,215	156	139	1,510

*Primary care pharmaceutical cost estimates not available.   (Source: R.C.of P., 2000)

The above figures do not take into account the total true cost of smoking related problems facing the British public. For example, it does not take into account any extra costs to the rest of the general public (e.g. the cost of the harmful effects of passive smoking, the cost for the utilisation of scarce health service resources or any reduced levels of productivity in the workplace) (Godfrey, Edwards, Raw, & Sutton, 1993). The approximate financial cost to the nation is estimated to be closer to £80 billion at 1997 prices (R.C.of P., 2000). Physiologically, the loss to the nation due to

deaths, resource costs and losses in productivity are enormous and very difficult to be presented in precise terms. However, as a self-inflicted habit, it would seem that only cessation would be an answer to these costs.

1.1.2: Pharmacological Effects

The pharmacology of cigarette smoking is a vastly complex area and it is not the purpose of this thesis to attempt to identify specific pharmacological-behavioural relationships. Rather, the focus here is on the overall impact of smoking as a persistent habit upon PM performance. Smoking is accepted as being the fastest and most efficient way of absorbing a range of compounds into the body. The human lungs are designed to rapidly absorb oxygen through a fine network of blood capillaries and by virtue take up a range of other chemicals present in tobacco smoke. The gaseous mixture carries tar droplets into the lungs where they settle on the lining of the lung allowing the compounds to be absorbed into the bloodstream (see e.g. Parrott & Garnham, 1998). There are over 4000 gaseous and tar-borne constituents of cigarette smoke and the vast majority of these constituents have not been researched with regard to psychological effects. The primary areas of smoking-related research have largely been concerned with the effects of the physical health of smokers (see e.g. Mannino & Buist, 2007) with some interest in the effect of withdrawal and cessation effects of smoking on psychological issues, such as mood (Parrott et al, 2004). Having said that, it is potentially of value to consider briefly what key components of cigarette smoke might be implicated in any effects found in the current research.

One of the main gaseous components of cigarette smoke is carbon monoxide (CO), which is a colourless, odourless and tasteless, highly toxic gas with molecules consisting of one carbon atom and one oxygen atom. The CO from the cigarette smoke is absorbed by the haemoglobin in the red corpuscles of the blood. Normally, the haemoglobin will combine with oxygen to form oxyhaemoglobin that is transported to all tissues of the body. When the oxygen is released it is utilised in cell metabolism. However, human haemoglobin has a much greater affinity for carbon monoxide (CO) than for oxygen. Consequently, inhaling tobacco smoke with a high level of CO diminishes the oxygen carrying capacity of the blood (Hamill & O'Neill, 1969). This comprises the potential for unsatisfactory oxygen delivery to tissues, therefore cells that lack oxygen are unable to operate and any energy dependent processes will subsequently die (Parrott et al, 2004). CO poisoning has been found to impair cognitive function in survivors in the past, including resulting in attentional difficulties and executive function (Hopkins & Woon, 2006).

Perhaps the most widely investigated pharmacological component in tobacco smoke is nicotine. Nicotine is widely accepted to be the primary psycho-active agent in cigarette smoke (Henningfield & Zeller, 2006) and is acknowledged as one of the major influences in the continuing prevalence of smoking. This is because nicotine is highly addictive and many of the other psychological effects of smoking reported have been attributed to its pharmacological properties (Dani & Heinemann, 1996). The inhalation of smoke generates a 'bolt' of nicotine that creates a euphoric sensation in the brain within seven to ten seconds. In low concentrations (an average cigarette yields about 1 mg of absorbed nicotine) the nicotine acts as a stimulant in

mammals and is one of the main factors responsible for the dependence-forming properties of tobacco smoking (Hoffmann & Hoffmann, 1998). According to the American Heart Association, "Nicotine addiction has historically been one of the hardest addictions to break. The pharmacological and behavioural characteristics that determine tobacco addiction are similar to those that regulate addiction to drugs such as heroin and cocaine" (US Surgeon-General's Report, 1988).

With regard to the psychological functioning, smoking has important effects on the brain's physiology and these relate largely to the nicotinic cholinergic receptors (nAChRs). Nicotinic receptors have been found on neurons throughout the brain, including the cerebral cortex, thalamus, hypothalamus, basal ganglia, mid-brain and the hind-brain (Brody et al, 2004). Nicotine works by direct interaction with these receptors, interfering with the normal functioning of neurotransmitters in the synapse (Jones, Sudweeks & Yakal, 1999). The nicotinic receptors modulate the release of neurotransmitters such as acetylcholine, norepinephrine, dopamine and serotonin. The presence of nicotine can lead to:

- An increase or decrease in the amount of neurotransmitters released.

- Inhabitation of acetylcholine receptor sites providing sustained stimulation or preventing the action of other neurotransmitters.

These neurotransmitters are connected with a range of psychological and behavioural aspects such as memory, attention and mood. Furthermore, chronic exposure to nicotine enhances the growth of nicotinic receptors. In humans, the density of nicotinic receptors of smokers can be up to three times that of non-smokers. This may be the brain's attempts to overcome the de-sensitisation of the

neurons that has taken place (Hulihan-Giblin, Lumpkin, & Keller, 1997). However, the brain's apparent attempts to rectify the de-sensitisation may also point towards a high dependence upon smoking and the highs and lows of the chemical imbalances. This may be represented in the function of the dopamine (DA) pathways that are believed to contribute to the advance of addiction to nicotine and hence, tobacco. Increased DA overflow is alleged to increase the pleasurable impact derived from the actions associated with the intake of nicotine. As a result, the expectation that the individual will repeat the activity is generally enhanced. In addition, the stimulation of dopamine neurotransmission in these reward circuits is consistent with the effects on neurons of other well-known drugs of abuse (i.e. cocaine and amphetamine). (Dani & Heinemann, 1996).

There can also be other characteristics when considering smoking. During times of abstinence, several cognitive mechanisms may become active. There may be an increase in the desire for smoking because a person may find difficulty in being able to pay attention at work or to specific tasks. Alternatively, it might increase the desire for smoking by increasing the significance of cigarette-smoking over other rewards by reminding the person of mood states associated with smoking or fatigue states that are relieved by smoking. In the case of fatigue, there can be an increase in the requirement to smoke because smokers believe from their previous experience, that nicotine counteracts the fatigue and normal mood changes and increases their attention levels. Fatigue, which often leads to depression, can also increase smoking needs and this may lead to more routine cigarette smoking (Corwin, 2002).

As nicotine ingestion impacts upon mood via the reward systems in the brain it has been suggested that an impact on cognition would be observed due to nicotine's activity in neurotransmitter systems closely linked to memory and attention. A number of researchers have examined improvements in the cognitive function following nicotine administration (Levin, McClernon & Rezvani, 2006). Others have found deficits. For example, Richards, Jarvis, Thompson, and Wadsworth, (2003) produced results that showed smoking (hence, nicotine) was associated with cognitive impairment. In contrast, Mendrek et al, (2006) completed a study that provided evidence that working memory deficits were particularly associated with acute withdrawal from smoking. An extensive literature exists that demonstrates the addictive nature and injurious consequences of tobacco smoking (see e.g. Godfrey et al., 1993; Harris & Hutton, 1998; Department of Health Survey, 2000; Parrott, et al., 2004; Comer, 2007). Indeed the health-related evidence is so compelling that it has perhaps negated the need for further in-depth investigation of the complex pharmacology of smoking. However, it is also clear that smoking can have a range of psychological effects some of which are considered in the following section.

1.1.3: Psychological Effects

Most smokers report that the psychological effects of smoking include feelings of pleasure, self-confidence and heightened alertness (Kassel et al, 2007). In the younger groups of smokers, these benefits of smoking are felt to outweigh the many expressed disadvantages that are regularly promoted by the mass media and the medical profession (Wakefield, Flay, Nichter, & Giovino, 2003; Brender, 2006). The question of whether smoking provides true beneficial effects is still considered by

many to be debatable (Heishman, 1998; Parrott & Garnham, 1998) but others, (Warburton, Revell & Walters, 1988; Wesnes & Parrott, 1992) suggest that smoking/nicotine can be beneficial. Smoking's benefits are quoted as reducing aggression, improving focus on tasks, increased vigilance, decreasing weight gain and improved moods (Perkins & Stitzer, 1998; Halpern-Felsher, Biehl, Kropp & Rubinstein, 2004). However, they have difficulty in explaining why the two other major justifications for smoking dependence (i.e. euphoria and withdrawal of relief), are rarely used by smokers when describing the benefits that smoking gives. Euphoria is reported very rarely, 10% of the time (Pomerleau & Pomerleau, 1992), while relief from the avoidance of withdrawal symptoms has been denied by up to 77% of adolescents (Breslau, Kilbey & Andreski, 1994). Even higher numbers, around 80-90%, have stated that smoking helps them to cope with stress but consistently failed to provide empirical evidence to support this belief. In fact, when smokers are deprived of cigarettes they typically report feelings of poor concentration, irritability, anxiety and tenseness. This leads to poor concentration and reduced alertness on cognitive tasks (Parrott et al, 1996).

1.1.4: The effects of smoking upon memory and cognition.

Cognition is used as an umbrella term to refer to all mental processes such as remembering, thinking, conceiving, and reasoning. Memory is a crucial part of cognition which facilitates the storage, maintenance and retrieval of information across short and long periods of time (Baddeley, Eysenck & Anderson, 2009). This thesis has focused on prospective memory (PM), but most of the current literature

has focused upon the deleterious effects of smoking upon cognition and retrospective memory (RM) and the following section reviews this literature. The effects of nicotine and smoking on human cognitive performance have been found to be very mixed, with some research showing deficits, some improvements and others showing no effects at all. Some of these varying findings are contained in the studies conducted by the following authors (see for example, Roth, Lutiger, Hasenfratz, Battig & Knye, 1992; Ernst, Heishman, Spurgeon & London, 2001; Hendricks, Ditre, Drobes and Brandon, 2006; Evans & Drobes, 2008). The following section reviews the literature on smoking, non-smoking and abstinence upon cognition and memory.

1.1.4.1. Improvements

Some studies have shown that smoking can improve performance on vigilance tasks and rapid visual information processing (Wesnes & Warburton, 1983). In this study, the effects of four strengths of cigarettes: 0.9mg, 1.3mg, 1.5mg and 1.7mg of nicotine and tar yields, were observed on rapid information processing performance. Rapid information processing was measured by requiring the participant to press a space bar as soon as possible when a particular set of digits appeared on the screen, with speed and accuracy (correct/incorrect response) being measured. Performance was measured over multiple trials. Twenty five smokers were tested over several days with each of the cigarettes and also in a non-smoking control condition. The testing was counterbalanced over a number of days. A 5 x 5 Latin Square Design counterbalancing method was used so that no order effects are introduced. Their results showed that smoking helped to prevent decreases in speed and accuracy across trials when compared to the non-smoking condition. In addition, the higher

nicotine containing cigarettes showed improved performance in relation to low-nicotine cigarettes.

Provost and Woodward, (1991) used a Stroop test on twenty non-smoking participants who were given either a 2 mg oral dose of nicotine (equivalent to smoking two popular branded cigarettes) or a placebo. The Stroop is a test in which the person is required to name the colour of the ink in which words are written, with the words being incompatible colour names (e.g. the word 'Brown' presented in red ink) and is seen as a test of attentional capacity and mental flexibility. The results demonstrated that nicotine had no effect on colour naming or word reading, but did increase the rate at which incompatible-colour word naming speed occurred on each successive occasion. The authors concluded that nicotine enhanced learning across trials and therefore led to improvements in cognition.

Further evidence that smoking could improve cognition and memory comes from Rusted, Graupner, Tennent and Warburton, (1998). Rusted et al reported two studies which looked at the effects of nicotine on memory in minimally deprived smokers. In experiment 1, recall was significantly greater for semantically related words following nicotine ingestion when compared with unrelated words. In experiment 2, they examined the effect of nicotine on 2 types of lexical association: semantically related items, and words that were associated by derived meaning (also known as encapsulated word pairs). Smoking nicotine improved recall for the semantically related words but not for the encapsulated words. In summarising, the authors concluded that smoking nicotine improved some aspects of verbal memory.

25

Further research providing support for improvement in cognitive functions due to the ingestion of nicotine was carried out by Warburton, Skinner and Martin, (2001). In this study 40 participants were studied and formed two groups: 20 of whom smoked a nicotine-containing cigarette and the other half a denicotinised cigarette. Following smoking, each group was further subdivided into two groups: one which was presented with a series of trials that each started with the presentation of a "decision word" and they had to say whether it represented something living or non-living; and a second group who were required to state whether the word had 1 or 2 syllables. Following this each participant was presented with a Stroop test, and finally, unexpectedly, they were given a free recall task. The results showed that those who had smoked the nicotine-containing cigarette showed quicker decision-making and colour naming, and recalled more semantically-related words on the free-recall task than those given the denicotinised cigarette. The authors concluded that nicotine mediates more effortful processing via the cholinergic system that can be used to improve attention and memory encoding.

1.1.4.2. Mixed effects.

Roth et al, (1992) noted: "Smoking and nicotine effects on memory are contradictory. Improvement, no change, and impairment have all been observed." The Roth et al study compared learning, retention, and retrieval amongst two groups of smokers: one group which smoked within 1 hour after getting up in the morning and a second group who smoked following a delay of several hours after getting up in the morning. Significant differences were obtained between those smokers who

usually started smoking within 1 hour after getting up and those who started later. Using a maze learning test and a word recognition task, later starting smokers performed better when deprived from smoking than when they had recently been smoking, whereas early starting smoking groups performed better following normal smoking than when deprived, particularly when the test took place near to their normal smoking time. This data added to the notion that there are mixed effects of smoking upon cognition.

Parrott and Garnham (1998) compared current smokers, non-smokers and overnight deprived smokers on a series of mood questionnaires and cognitive tasks, the latter comprising a letter cancellation task and a simple addition/subtraction mental arithmetic task, before and after a cigarette/rest period. Initially the deprived smokers reported more mood problems (such as stress, depression, poorer concentration) than the other two groups. After a cigarette/rest period all three groups were similar in their mood levels. This suggests the reversal of abstinence effects on mood in deprived smokers. In terms of the cognitive tasks, there was no difference between the groups on letter cancellation before/after a cigarette/rest period; whereas the deprived smokers carried out fewer arithmetical tasks overall, both before and after the cigarette intake/rest period. The findings suggested some cognitive deficits associated with smoking deprivation, but not across both cognitive tasks.

Evans and Drobes (2008) conducted a review of the research concerning nicotine's effect on simple and complex cognition. Among the conclusions reached was one that nicotine appears to enhance cognition when simple tasks which involve

low memory loads were involved, but when more complex tasks were used – such as multitasking (remembering to do several tasks simultaneously) then the impact of nicotine upon memory is reduced. Another conclusion reached was that individual differences may play a role in the effects of nicotine upon cognition and that consideration be given to the use of technological improvements in neuro-imaging studies (e.g. fMRI technology) to map the areas of the brain that support memory when smoking nicotinised cigarettes.

Other research has found no change in cognitive performance associated with prolonged smoking across time. For example, Whittington and Huppert, (1997) examined smoking and changes in cognitive function over time in elderly persons (over the age of 50) in a longitudinal study stemming over a seven-year period. Interviews were held with 5252 people and of these 83.7% agreed to take part. At both the earlier and later interviews respondents were asked whether they smoked, had ever smoked, still smoked and if they did, how much they smoked. Four cognitive tests were administered to the participants in 1984-1985 period and again in the 1991-1992 period, comprising; memory, reasoning, simple reaction and choice reaction times. The results revealed no significant changes between groups on cognitive performance across time. In addition, there was no relationship between change scores and when smokers last had a cigarette, nor were the scores related to changes in smoking behaviour.

1.1.4.3. Deficits

Spilich, June and Renner (1992) manipulated low and high memory loads and observed what effect smoking might have upon cognition within these contexts. Spilich et al accessed regular smokers or non-smokers. The regular smokers were divided into two groups; a group who had just smoked, and a second group who had been deprived for 3 hours prior to the study. All three groups (non-deprived smokers, deprived smokers, and non-smokers) were compared on a series of tasks. The participants first completed a visual search task (where they had to identify a target letter amongst a visual array); a visual-attentional task (where the participant had to record text changes in letters on a computer screen); a Sternberg memory test (where the person had to identify a previously presented item on a computer screen); a comprehension task (where an ambiguous array of data appeared on the screen and the participant had to de-code, rearrange and make sense of the confusing data); and finally, the fifth task was a driving simulation test that comprised a road race task which required multi-tasking.

The findings revealed that while cigarette smoking had positive effects on the performance of simple tasks, it had negative effects upon the performance of tasks requiring high demands upon problem-solving skills, such as the driving simulation (road race) task, which rely on working memory and long-term memory systems. They concluded that where more complex cognitive tasks are involved smokers perform worse than non-smokers.

Heishman and Henningfield (2000) studied the effect of nicotine administration to non-smokers across an 8 day period. Twelve non-smokers were administered four

doses of nicotine gum each day in the order 0mg, 2mg, 4mg and 8 mg of nicotine and their performance on a number of tasks were measured. Working memory was measured by requiring the participant to search for a series of letters within an array and measuring accuracy in recall and speed. A second working memory task included a digit recall task in which the participant had to identify the missing digit from a previously presented series of digits. The findings revealed that although nicotine increased the rate of responding on the working memory tasks, accuracy in recall declined. This study supports the notion that nicotine produces deficits in complex cognitive tasks.

Ernst et al (2001) tested 14 current smokers, 15 previous smokers and 9 people who had never smoked on cognitive performance. The tasks comprised of a visual attention task (a search for 2 letters amongst an array of letters), a verbal reasoning task, and an N-back working memory task (where a series of items are presented individually and the person has to identify whether a subsequent item appeared 1 trial, before, 2 trials before, and so on). A double-blind procedure was utilised using gum that either contained nicotine (4 mg) or a placebo. The smokers were asked to refrain from smoking for 12 hours prior to the tests which began each day at 8 a.m. The results indicated that there were no interactions of nicotine ingestion (or placebo) with group type (smokers, previous smokers, never smoked) on any of the tests. However, nicotine gum increased reaction time when compared with the placebo, but did not produce any enhancement with verbal reasoning and produced actual declines in accuracy in working memory. Again it was concluded that nicotine ingestion leads to decline in complex cognitive tasks, in this case working memory.

Other studies have examined cigarette smoking in comparison to cognitive performance in middle-aged subjects. Kalmijn, van Botel, Verschuren, Jolles and Launer, (2002) used a battery of neuropsychological tests that measured memory function (a letter digit substitution test) and a word fluency test (where one names as many animals as possible in 60 seconds), an abbreviated Stroop Colour Word Test, and cognitive flexibility (time taken for higher order information-processing) on men and women aged 45-70 years. Current smokers scored significantly worse than non-smokers and previous smokers on the verbal learning test and the Stroop test, with the previous smokers falling in between the other two groups. In addition, current smoking status and the number of pack-years of smoking were linked to a reduced performance on psychomotor speed tests and cognitive flexibility assessed throughout the five year period. The authors concluded that the effects of smoking impaired cognition and that the deficits shown were comparable to them being approximately 4 years older in terms of cognitive decline.

Hill, Nilsson, Nyberg and Backman, (2003) examined the relationship between cigarette smoking and cognitive function in healthy Swedish adults (aged 35 – 80 years), comparing current smokers with people who had never smoked. They tested the two groups on a Block design task that involved learning 12 unrelated nouns whilst simultaneously sorting a deck of playing cards into two piles, followed by two untimed tasks, one tested general knowledge about Swedish people and a word comprehension task. Smokers produced performance decrements on measures of the more demanding cognitive tasks (i.e. the Block design task which involved multitasking). In addition, the number of cigarettes smoked and time spent smoking

31

was associated with poorer performance on the Block design task. No between-group differences were noted on the other two untimed tasks. They concluded that cigarette smoking may exert its greatest detrimental effect on cognitive tasks that require greater processing resources.

Richards, Jarvis, Thompson and Wadsworth, (2003) studied the effects of cigarette smoking in the middle age-groups on a range of tasks. Using a sample of over 1900 people aged 35, 43 and 53 years of age with a smoking frequency of zero, 1 to 20, 20 or more cigarettes per day. The participants were measured on verbal memory (the free recall of words across a series of trials). Speed and concentration was measured by a visual search test where participants were asked to delete target letters within an array of letters within 1 minute. The results of the study indicated that cigarette smoking was associated with a faster decline in verbal memory and slower visual search speed across the age ranges. Those between the ages of 43-53 years who declared that they smoked above 20 cigarettes per day showed the greatest decline when compared to non-smokers. Neither gender nor other aspects such as socio-economic factors were linked with these declines. The authors concluded that smoking into mid-life was directly associated with increased cognitive deterioration and suggested that those who smoke into later life may be at very high risk of clinically significant cognitive decline.

Several recent studies have covered the spectrum of age – from adolescents aged 11 to adults aged in their 80s. One study that used a variety of memory tests in order to determine the effects of chronic smoking on the cognitive

performance of adolescents was Jacobson, Mencl, Constable, Westerveld and Pugh, (2005). They assessed the performance of adolescent smokers, abstinent smokers and non-smokers on verbal memory tests (Hopkins Verbal Learning Test – Revised) that involved the immediate and delayed recall of verbally-presented words. Working memory was also tested using the N-back procedure (described earlier) which measures monitoring and recall within working memory. The results revealed that smokers showed no impairments on the verbal learning task but significant impairments on the working memory performance tests (the N-back task), when compared with the non-smokers. Smoking abstinence produced even more severe deficits on the working memory tasks. It was concluded that a history of smoking has a detrimental effect upon working memory performance (but not on a simple verbal memory recall task) and that when smokers are put into an abstinence paradigm they show even more detrimental effects on complex working memory.

Fried, Watkinson and Gray, (2006) examined the effects of current and past regular cigarette smoking in 112 young adults. They were evaluated using a battery of neuro-cognitive tests administered to the participants at 9-12 years of age, prior to their commencement of regular smoking and then again at 17-21 years. The smokers provided self-reports of their smoking habits as being heavy (>9 cigarettes per day) and light (<9 per day) for current smokers and former smokers (those who had not smoked within the last 6 months). In addition, there was a control group who had never smoked. Each of the groups completed a series of cognitive tasks, including IQ tests, memory tests (the immediate and delayed recall of items), processing speed (the speed at which one can recall items), sustained attention, vocabulary and

abstract reasoning tests. The results of the tests indicated that current regular smokers performed worse than non-smokers in a number of areas, in particular on the verbal/auditory tasks, oral arithmetic and auditory memory. Former smokers differed from the non-smokers only in the arithmetic task, therefore showing some improvements. They concluded that regular smoking during early adulthood is associated with cognitive impairment but that these defects may be reversed when smoking is stopped.

Paul, Brickman, Cohen, Williams, et al, (2006) assessed cognitive measures on smokers and non-smokers <45 years and >45 years. The tasks included; simple reaction time (motor tapping speed) and choice reaction time (touch an illuminated circle from a choice on the computer screen as fast as possible), and a letter fluency task (described earlier in thesis) as an executive function test. Executive function is a term used to refer to a set of processes that is an attentional controller and is responsible for the flow of information within cognition. Digit span and visual memory span were also measured (recalling digits or visual items from a series of items presented on screen) across a series of trials. Finally, verbal memory span was measured by requiring the participant to recall a list of words after a delay. The results indicated that smokers performed worse than non-smokers on all of the cognitive measures, particularly when a delay was introduced. Older smokers' performance was weaker than the younger smokers and non-smokers on all tasks. It was concluded that smokers showed deficits on cognitive tasks when compared with non-smokers, with age producing even more advanced declines on the measures.

More recent research has also found that smoking is associated with a greater risk of poorer memory in middle age populations (Sabia, Marmot, Dufouil & Singh-Manoux, 2008). They used the Whitehall II study of people aged between 35-55 years (measuring general health behaviour and status) as a baseline Of the original number of 5346 participants only 4630 were able to be retested five years later by Sabia et al. They tested these on a memory reasoning task (where the participant had to verify whether a statement was correct/incorrect) and verbal fluency (described earlier in the thesis). After adjusting for age and sex, smokers performed worse on memory recall and fluency tasks when compared with non-smokers and ex-smokers. Sabia et al concluded that continued smoking was associated with a greater risk of poorer memory.

1.1.4.4. Abstinence

Studies on the impact of abstinence upon cognition typically look at the impact of abstinence from smoking across a relatively short period of time, often from a few minutes to several hours, and in some cases a few weeks. These studies have found evidence of a range of psychological changes, including irritability, poor concentration, restlessness or cigarette craving (see e.g. Parrott & Garnham, 1998). A number of these studies have found deficits in cognitive performance when tested during these shorter abstinent periods. Hendricks, Ditre, Drobes and Brandon, (2006) found attentional problems emerging from 30 minutes of abstinence, whilst Jacobson et al., (2005) also found that abstinent smokers suffered acute impairment in verbal memory (word recall) and working memory (using the N-back procedure).

Xu et al., (2005) explored the effects of abstinence on working memory observing the participants completing the tests using functional magnetic resonance imaging (fMRI) techniques. Six smokers performed a letter version of the N-back working memory task under two conditions – first under stated satiety (less than 1.5 hours abstinence), then under a longer state of abstinence (overnight abstinence >14 hours). The fMRI results indicated that there was task related activity in the prefrontal cortex. Recent smokers (those who did not abstain overnight) demonstrated lower pre-frontal brain activity in the 1-back task, but greater activity in the more difficult 2-back and 3-back tasks. After overnight abstinence, post-smoking pre-frontal brain activity was lower than before smoking on the 2 N-back task and higher than before on the 3 N-back tasks, suggesting that a period of recent abstinence leads to more effortful processing in more demanding working memory tasks due to cigarette deprivation.

Other studies have also demonstrated that attentional skills deteriorate when smokers were required to abstain from cigarette smoking, thereby substantiating evidence that account for impaired performance with any forms of interference in smoking levels. For example, Giannakoulas, Katramadas, Melos, Diamantopoulos and Chimonas, (2003) examined 20 male pilots who abstained from smoking for 12 hours during a flight, during which time they were requested to execute their normal flight duties. After landing an aircraft, the intensity of the nicotine withdrawal, its physiological parameters and psychological functions, including cognitive tasks, were all measured. The pilots completed a questionnaire, had their pulse rate and heart rate measured and carried out a series of computerised tasks for mental

arithmetic, visual vigilance and free-recall of visual images. At a later time the pilots repeated the flight procedure but not in a smoking deprivation state (the pilots acted as their own controls). Most symptoms reported during deprivation were craving, nervousness, tension and fatigue, lack of concentration, lack of alertness, prolonged reaction time, irritability and impairment of judgement. All of the tests recorded an impairment of cognitive function during abstinence when compared with their baseline (control) measures. It was concluded that smoking abstinence may have a deleterious impact upon flight safety.

Mendrek, Monterosso, Simon, Jarvik, Brody et al, (2006) designed a study to examine effects of cigarette smoking and withdrawal on working memory. They compared 15 smokers and 22 non-smokers on the N-back task that was administered in two test blocks on each of two days. On day one, smokers were tested after more than 13 hours of abstinence and on another day testing began less than an hour after smoking. Results of the study showed that the performance of smokers after the 13 hour deprivation was significantly less accurate than that of the non-smokers, whereas at the 1 hour abstinence period there was no difference between their performance and that of non-smokers. They concluded that their findings provided further evidence for a deficit in working memory associated with acute abstinence from smoking.

In summary, the above research clearly indicates that there are mixed findings in relation to what impact nicotine administration and smoking has upon cognition. Some studies provided support for enhancement, some research found no benefits or

disadvantages and others have established that smokers perform worse than non-smokers. Where studies have shown that smoking/nicotine enhances cognition the benefits gained appear to be typically found on the simple cognitive tasks. However, when more complex tasks were devised that engaged multiple cognitive resources those benefits become lost. Under these circumstances it was found that smokers performed worse than non-smokers. In addition, abstinence from smoking may result in further decrements in memory processes, such as working memory, but these studies have typically focused on abstinence over short periods of time.

The vast majority of research on smoking and its impact upon cognition and memory have principally concentrated on retrospective memory (RM) that involves the, retention and retrieval of previously-presented target material. Very little consideration was given to everyday memory, of which prospective memory (PM) – that area of memory involved with the act of remembering future events and activities is a good example. The lack of research into the impact of smoking upon PM has provided the impetus for the current line of research in this thesis.

1.2: Prospective Memory

1.2.1: What is Prospective Memory?

Graf and Uttl (2001) concluded that prospective memory was a distinct and separate part of episodic memory and like, retrospective memory (RM), can be considered a sub-domain of memory. Prospective memory (PM) has been defined as 'remembering to remember' (Winograd, 1988) or memory for future actions and/or intentions (Brandimonte, Einstein, & McDaniel, 1996) and differs from retrospective forms of memory in that PM is specifically used for remembering future intentions/actions. PM recall is triggered by some stimulus; a cue (e.g. a stimulus appearing in the environment – known as event-based PM) or by the passage of a specific period of time (e.g. remembering to do something at regular time intervals – known as time-based PM). A typical example of an event-based PM task would be when a person meets with a friend - the cue, which could then remind them of some message they would wish to pass on - the intention. A typical example of a time-based PM task could be remembering to telephone a relative at 6 p.m. when 6 p.m. arrives and then remembering to phone that relative on a regular basis at the same time.

Consequently, PM is being used consistently throughout the day and is considered to be continuously active. In this sense PM is a good reflection of everyday memory. Examples of PM in the real world include remembering to pay bills on time, to purchase food items, to meet with friends for coffee, or remembering to return books to the library. Accordingly, when PM fails to act as it should, this can have serious repercussions on everyday life (e.g. embarrassment at not meeting with a friend) and in extreme cases even catastrophic consequences (e.g. when an aeroplane pilot forgets to carry out vital checks at the appropriate time during the

flight). In reality it should be understood that RM and PM are interlinked. This relationship was considered by Kliegel, Jager, Altgassen, & Shum, (2008) where they stated that the distinction between retrospective and prospective memory was not so clear-cut. They felt that prospective memory, by necessity, included a number of elements of retrospective memory. For example, when remembering to meet with a friend and pass on the message to that friend this would incorporate the intention and act of meeting with the friend (the PM element) and the content of the message that had to be recalled (the RM element).

1.2.2: Event v Time-Based Prospective Memory

An important distinction within PM literature is the comparison of event versus time based PM. An example of event-based PM is where a person might carry out an isolated action (e.g. to visit a bank in order to pay a bill). Or alternatively, they may be part of a network of related plans such as a visit to the local shopping area in order to buy several goods from a list. An example of time-based PM is where a person might carry out a series of actions at regular time intervals (e.g. where a patient has to remember to take his/her medication at regular time intervals).

Specificity may well include the timing as well as the content of a plan and PM involves time-monitoring as well as event-remembering. Ellis (1988) devised the terms 'pulses' and 'steps' in order to differentiate between the two. She described a pulse as a plan that specifies some exact time at which it must be implemented (i.e. "Saturday at 3 p.m"). The step was much more indefinite, (i.e. "next time I see you"). Ellis suggested that the pulses are better recalled than steps and were judged to be

much more important. In addition, people are far more likely to use an external memory aid, such as a diary, to remind them of pulses. Variations in the specificity of timing lead to distinctions that rest on priority. Some plans are vitally important and so are given a higher priority while others that are less important are given a lower priority.

However, not all plans are implemented, even if remembered and so varying plans may compete with each other for implementation, both as events and for time. As an example, busy people will have numerous sets of plans waiting to be implemented and so, some will be postponed, some used and others discarded. Einstein and McDaniel (1990) differentiated between these two kinds of prospective memory using the basis that cues trigger retrieval. They found that time-based PM requires some form of performance either at a specific time or after a particular period of time has passed. Event-based PM on the other hand requires the action to be cued by an object, a person or some other event such as, winding up a clock reminds one to take their watch for repair. They observed that time-based PM tasks were generally much more difficult to remember because the passage of time needs monitoring and that remembering is self-initiated whereas in event-based PM a cue is supplied by the context or event (i.e. the person approaches a particular store). In another study Einstein and McDaniel, (1990) found that elderly people showed no deficits in event-based memory but were much poorer in time-based tasks. The differences between various types of PM are significant because they can, more than likely, influence its efficiency. From this it can be suggested that those high-priority event-based plans which are part of a network of plans are far more likely to be

remembered than time-based plans. Thus there is good evidence for the distinction between differing types of PM.

1.2.3: Measuring Prospective Memory

PM can be measured using a number of techniques, mainly utilising self-report measures, laboratory-based and naturalistic tasks.

1.2.3.1. Self-report measures of PM.

The use of self-reports in the form of questionnaires typically include statements remembering to carry out an action or remembering to be somewhere, at some future point in time. One example of such a questionnaire is the Prospective Memory Questionnaire (PMQ) developed by Hannon, Adams, Harrington, Fries-Dias and Gibson, (1995). The PMQ is a valid and reliable self-report that measures three aspects of everyday PM on a series of nine-point scales and a strategy use scale. Fourteen questions measure long-term PM, (e.g. "I forgot to send a card for a birthday or anniversary last year)". Fourteen questions measure short-term PM, (e.g. "I forgot to put a stamp on a letter before mailing it (last month)". Ten questions measure internally-cued PM, (e.g. "I forgot what I wanted to say in the middle of a sentence"). The scale ranges from 1 (where least forgetting is evident) to 9 (where there is a great deal of forgetting reported), the greater the score, the more faulty one's prospective memory. In addition, 14 questions make up the techniques to remember scale, which provides a measure of the number of strategies used to aid remembering, (e.g. "I make lists of things I need to do"). The techniques to

remember (TTR) scale ranges from 1 (where few strategies are used) to 9 (where a high number of strategies are used).

The other main questionnaire for measuring PM is the recently developed Prospective and Retrospective Memory Questionnaire (PRMQ) (Crawford, Smith, Maylor, Della Sala, & Logie, 2003). This questionnaire was developed to provide a measure of prospective and retrospective memory lapses in everyday life. The format consists of 16 items, eight of which cover lapses in PM whilst the other eight are concerned with lapses in retrospective memory (RM) failure. Examples of questions from the PRMQ relating to PM and RM would be, for example, "Do you decide to do something in a few minutes time and then forget to do it?" Or, "Do you fail to recognise a place you have visited before?" The higher the score on these scales, the more forgetting the person has reported.

Self-report measures, such as the PMQ and PRMQ can be useful in the sense that they ask questions about every day, real-life activities, thus improving the ecological validity of the technique. However, self-reports can be subject to a number of problems that may reduce their validity. For example, it depends upon the participant being truthful, the participant being accurate in their responses (eg they may exaggerate or underestimate their own memory capabilities), and they may be influenced by anxiety, depressed mood and personality. Although self-reports can be a useful means of assessing everyday behaviour, the notion that one can test a person suspected of having a poor memory by asking them questions about their memory

creates a type of memory paradox. This may be inherent in self-reported memory tasks and should be considered when interpreting findings from such measures.

1.2.3.2. Laboratory-Based Measures of PM.

A laboratory-based scenario is where one has to remember to carry out particular activities at particular points in an experiment. For example West et al (1984) required the participant to remember to keep an interview appointment as one test of PM and also, at the beginning of the interview, requested the participant to locate a folder and hand it the interviewer at the end of the meeting. In another experiment, Einstein and McDaniel (1990), asked participants to study a list of words ready for recall. The PM task was to recognise the word and press a key when the target word occurred.

A recently developed laboratory-based task is the Cambridge Prospective Memory Test (CAMPROMPT) (Wilson et al, 2005). In this test participants are asked to work on a number of paper tasks (e.g. answering general knowledge questions) or doing a word-finder puzzle over a 20 minute period and remember to carry out a series of PM tasks within this time. The test includes six PM tasks, where three of them are cued by time and the other three are cued by events. In the time-based tasks, 2 of the three tasks are cued by a countdown kitchen timer and 1 by a clock. Examples of these time-based tasks include reminding the researcher to "Ring the garage" at a particular time, another example is to remind the researcher not to forget his/hers keys at a particular time during the experiment. In the event-based tasks, one task is triggered by a verbal prompt from the researcher, one by a beeper

going off during the study, and one by a particular event arising from the puzzle. An example of an event-based task is where the testee is required to change the particular task he/she is doing when a prompt about Coronation Street is reached during the puzzle. Following completion the researcher scores CAMPROMPT, with the higher the score the better one's PM functioning. This test shows high levels of validity and reliability (See Wilson et al., 2005).

However, laboratory-based approaches suffer from a number of problems and limitations. For example, there may be bias due to demand characteristics – where the participant becomes aware that they are being observed and may change their natural behaviour on this basis. There is also the possibility of other influences, such as researcher effects – where the experimenter may try to influence (or manipulate) the participant's behaviour in line with some expectation about the study (see e.g. Robson, 2002). A major limitation of the laboratory approach is that the situation becomes too artificial (e.g. asking the participant to complete a computerised test battery or remembering series of digits in a backwards order, the reverse digit span task). In this sense they often lack ecological validity in that they do not measure naturally occurring phenomena (see e.g. Neisser, 1978).

1.2.3.3. Naturalistic studies of PM.

Naturalistic approaches assess PM in situations that retain a close resemblance to tasks that occur in everyday life (Cohen & O'Reilly, 1996) and therefore are high in ecological validity. For example, West (1988) devised an experiment where young and older participants were asked to carry out a sequence of up to 14 everyday

actions (e.g. put a comb on a table, put a toothbrush in a bag, etc.) and recorded the numbers of errors where participants did not carry out the appropriate action and also the number of errors in terms of the order in which they were to be carried out. West found a clear age difference, particularly in those sequences requiring longer action periods. She believed this approach to be a valid measure of prospective memory that was involved in everyday tasks in that it had face validity.

More recent approaches include the Prospective Remembering Video Procedure (PRVP) which incorporates a video-based PM task. The PRVP task was constructed using a procedure described by Titov and Knight (2001) who suggested that the PRVP would provide a useful means for testing PM in a more naturalistic setting than, for example, normal lab-based PM measures (e.g. pressing a key when a target item appears at various times). In this thesis it was decided to use a similar format developed by Forster, (2003) who used a procedure that involved a 10-minute video clip comprising footage of a shopping district in Scarborough. The district was a busy shopping area comprising many retail shops, with modern shop fronts and signs. The view presented in the video was a mixture of shop fronts, passers-by, and some street retail stalls. Before watching the video clip, the participant was instructed to remember particular actions/items associated with particular locations on the video. For example, "When you reach Dixons, enquire how much Playstation 2 costs", and "When you see a woman sitting on a bench, ask her the time". There were 21 location-action/item associations and 1 point was awarded for each successful location-action/item recalled. This procedure has been used to uncover everyday prospective memory lapses in regular cannabis users when compared with

non-users (Bartholomew, Holroyd, & Heffernan, in press) as well as patients suffering from eating disorders (Seed, Dahabra, Heffernan, et al., 2005). The inclusion of everyday items increased the task's ecological validity. The use of naturalistic tasks of this nature provides a useful approach to studying PM within the real world. However, they do have their drawbacks. For example, they do sacrifice the element of control within the study and internal validity is therefore compromised (i.e. it is very difficult to control for extraneous factors within a naturalistic approach, such as distractions caused by passers-by or other events within the environment, that are beyond the researcher's control).

Laboratory scenarios are seen as a useful way of testing theory and application of PM, but there may be important aspects of real world PM tasks that are difficult to replicate within a laboratory setting (McDaniel & Einstein, 2007), such as the reality of distractions and delays that occur in the real world. Therefore real-world PM scenarios may best capture the intricacies of PM functioning within everyday life.

1.2.4: Substance Use and Prospective Memory

The use of recreational drugs has increased over the last $2 - 3$ decades with specific increases in the use of cannabis, MDMA (Ecstasy) and alcohol use (Hakkarainen, & Metso, 2009). Only recently have researchers focused upon what impact these drugs have upon prospective memory (See Kliegel, et al., 2008 for review). These focus points include PM deficits associated with ecstasy, cannabis, alcohol, and more recently smoking.

47

Recent research has shown that regular use of ecstasy impairs everyday prospective memory, particularly long-term aspects (e.g. forgetting to meet with friends, post a letter on time, etc.). This research has utilised the Prospective Memory Questionnaire (PMQ). The PMQ contains three sub-scales that provide self-reported measures of short-term and long-term aspects of PM. Ecstasy is associated with reports of more long-term memory lapses when compared to non-ecstasy controls. These results were observed after statistically controlling for age, other drug use and strategies used (e.g. Heffernan et al., 2001; Rodgers et al., 2001, 2003; Scholey et al., 2004). More recently, ecstasy users have been found to recall fewer items on the video-based PRVP task than non-users (Heffernan & Bellis, 2008).

Cannabis has also been associated with PM deficits recently. Rodgers et al., (2001) found that prolonged use of cannabis is associated with short-term and internally-cued deficits in PM (using the PMQ). For example, forgetting to lock one's door upon leaving the house (an example of short-term PM) and forgetting what one came into a room for (an example of internally-cued PM). These results were observed after statistically controlling for age, other drug use and strategy use. In a more recent study Bartholomew et al., (in press) found that cannabis users recalled fewer items on the PRVP than non-cannabis users, but failed to confirm any difference between users and non-users on self-reported PM. Cannabis therefore appears to have a different effect upon PM than ecstasy use, in this case cannabis-related impairments on short-term aspects of PM, whereas ecstasy seems to impair long-term PM.

Recent studies have assessed PM functioning in excessive drinkers (those using above the recommended 21/14 units of alcohol per week for males/females respectively, using non-clinical samples) and compared performance with low-dose/zero-alcohol groups. In the first of this line of research (Heffernan, Moss and Ling, 2002) excessive alcohol users were compared to low-dose/zero-user controls on the PMQ. After statistically controlling for age, other drug use and strategy use, chronic heavy alcohol users showed global impairments in PM, (i.e., reported more memory lapses on all three PM sub-scales of the PMQ, when compared to matched controls). In a second study (Ling et al, 2003) adopted a world-wide-web design using the PMQ to assess the impact of different doses of alcohol on PM. This revealed that excessive use of alcohol was associated with impairments in the long-term aspect of prospective memory on the PMQ and there was also a dose-dependent increase in PM lapses evident, with more lapses reported as the amount of alcohol used increased. Similar deficits of this kind have also been found in teenagers who drink excessively (Heffernan & Bartholomew, 2006).

1.3   The impact of nicotine and smoking upon PM

Most of the studies associated with nicotine, smoking and memory have primarily focussed on retrospective memory (RM), with little attention being paid to prospective memory (PM). To date only 3 published studies have focused upon the impact of nicotine ingestion and PM, with a further 2 publications that have focused upon smoking *per se* and PM. The section that follows will firstly review the literature upon nicotine and PM, followed by the research that has focused upon smoking *per se* and PM.

1.3.1. Nicotine and PM performance

Rusted, Trawley, Heath, Kettle and Walker (2005) reported a series of studies that examined the effects of nicotine on prospective memory (PM). In the study smokers either smoked or abstained just prior to conducting the standard prospective memory (PM) task which involved them identifying specific target items within a lexical decision task procedure. Variations on the task were manipulated across the following two studies. These consisted of the participant being required to identify specific letters (i.e. the letter M and E) within a lexical decision task (LDT) and responding by pressing a key on the keyboard - seen as a more attentionally demanding task than the standard PM procedure. The final study manipulated the presentation of the tasks (the LDT and PM tasks), the type of target (letters or whole word) and provided different priority instructions given to those tasks (e.g. focus more on the LDT, or focus more on the PM task), making the task demands much greater. Overall the findings showed that under automatic PM conditions (the standard PM) no effect of nicotine ingestion was found (i.e. no difference between deprived and non-deprived smokers), whereas in studies 2 and 3 where greater processing demands were involved nicotine ingestion did improve recall on the PM task (when compared with deprived smokers).

More recently, Rusted and Trawley, (2006) looked at the effect of nicotine on the performance of the PM task. Participants were required to complete an ongoing LDT while maintaining the PM task (in which the person responded with a key press to particular target letters within the LDT). Half the participants were smokers and

the other half were non-smokers. Within each group half the participants received a nicotine nasal spray in a single dose of 1mg and the other half received an inactive placebo spray. The results revealed that nicotine improved PM under non-demanding conditions, but was shown to produce impairments under more demanding conditions (where the participant had to complete a concurrent auditory monitoring task alongside the PM task). It appears that when more demanding tasks are conducted alongside a PM task (where working memory resources are involved) resources may be spread across the different tasks and any nicotine-improvement is lost.

In a more recent study, Marchant, Trawley and Rusted (2008) found that nicotine (administered in the form of a nasal spray) enhanced PM (using the same methods as the previous study) performance under low arousal conditions (where a low cognitive load was required (i.e. where the person was required to solve simple anagram tasks) when compared with a placebo (non-nicotine nasal spray). Whereas under high arousal conditions (where there was a high cognitive load, i.e. in which they had to solve very difficult anagram tasks) the opposite occurred in that non-nicotine condition showed enhanced PM performance. It was concluded that nicotine enhances PM performance, but only under conditions where cognitive load or arousal is low.

It is clear from the three studies outlined above that the effects of nicotine ingestion upon PM is mixed, but on the whole enhancement is found under relatively simple task conditions, but when more demanding tasks are included (e.g. where

working memory is taxed) nicotine does not appear to be an enhancer for PM. This research also suggests that under highly demanding situations the reduced PM performance might be due to some form of over-arousal as a result of the nicotine-ingestion combined with the demanding nature of multitasking. It should be noted that the present thesis is concerned with smoking *per se* and not nicotine ingestion and therefore the literature on smoking and PM is reviewed next.

1.3.2. Smoking and PM performance

Heffernan et al, (2005) examined self-ratings of two aspects of everyday memory performance: long-term PM - measured by the Prospective Memory Questionnaire, and everyday memory - measured by the Everyday Memory Questionnaire (EMQ). Use of other substances was also measured and used as covariates in the study. After statistically controlling for other drug use and strategy use, smokers reported a greater number of long-term PM errors than non-smokers, and heavy smokers reported more lapses than light smokers suggesting a dose-dependent impact upon long-term PM performance. Smokers also reported more errors on the EMQ, although the trend for more memory errors amongst the heavier smokers was statistically only borderline (p=.057). These findings were taken as suggesting that there are selective memory deficits associated with smoking and that long-term PM deficits should be added to the growing list of memory problems associated with cigarette use.

In a more recent PhD study by Rash (2007) smokers were split into two groups: one group who abstained from smoking for 24 hours and a second group who did not

abstain from smoking. An additional control group of non-smokers were also included. All of the participants had to complete an LDT that involved a series of strings of words and non-words that the participants had to react to as quickly as possible by pressing either a Yes or No key to specify which type of word group. This simple task provided a quick method of deciding whether the word appearing on the screen was a correct word or a non-word and the appropriate reaction time was also recorded. Two PM conditions were also added, one event-based and one time-based. In the event-based PM task the LDT was used but incorporated a request to press the space-bar key on the computer when particular animal words (e.g. Monkey) appeared. The time-based PM task required the participants to press the space-bar every two minutes whilst completing a distracter picture-assembling task. The more correct responses on the PM event and time base tasks the better their PM functioning. The results revealed that non-deprived smokers showed the lowest levels of PM performance across the event-based and time-based PM measures, followed by the deprived smokers, with the non-smokers producing the highest level of performance on the PM tasks. It was concluded that PM performance was significantly impaired by smoking.

From the studies reviewed above, two things are evident. Firstly, the impact of nicotine upon PM appears mixed – with nicotine administration enhancing PM under low cognitive load conditions, but is associated with a reduction in PM performance when high cognitive load tasks are involved. Secondly, both Heffernan et al (2005) and Rash (2007) have demonstrated that consistent PM decrements are associated with persistent smoking *per se*.

One theory which might be used to explain these effects is the Multi-Process Model of PM by McDaniel and Einstein (2007). The theory maintains that PM tasks involve other memory processes, such as working memory and executive processes, a point re-iterated by other researchers in the area (Kliegel et al, 2008). McDaniel et al (2007) suggest that the complexity of PM tasks can be understood to be either automatic (where the retrieval process is effortlessly related via cues that have specific associations with the cue) or effortful (non-automatic) processing that demand greater cognitive resources (such as more memory capacity). An example of a simple automatic PM task might be one where the cue is evident (e.g. the person is holding the letter) and leads to an automatic response (e.g. where the person then posts the letter in the post box nearby). An example of a more demanding, effortful (non-automatic) PM task might be where the person has to plan in advance for a future activity and then remember to carry out that task after a period of time has elapsed (e.g. remembering to go to the grocery store on the way home from work). Therefore the findings outlined above are explicable in terms of nicotine improvement PM recall on the relatively simple PM tasks (Rusted et al., 2005) relying more on automatic processes, whereas on the more complex tasks (Rusted & Trawley, 2006; Marchant et al., 2008) nicotine produced decrements in PM recall due to the more effortful processing involved. The theory may also be used to explain smoking-related decrements in PM found by Rash (2007) who used similar time- and event- based PM tasks, but may not fully explain the self-reported deficits observed by Heffernan et al., 2005 - which are retrospective in nature and therefore not subject to current demands that might be placed on cognition.

1.4   Overall Rationale for Thesis.

This thesis focused upon what impact *smoking* might have upon PM. As noted, only two studies to date have focused upon smoking and PM. The first adopted a self-report web-based approach and the second chose a simple laboratory-based PM task. This thesis was driven by a need to extend the literature in order to develop a greater understanding of what impact smoking may have upon memory processes vital to everyday living, PM being the prime focus. Given that PM is crucial to independent living and that failures in PM can have an adverse effect upon one's social, occupational and personal life (McDaniel & Einstein, 2007), it is critical to clarify what PM deficits are associated with the use of such a dangerous drug. The thesis aimed to achieve this by exploring PM in smokers and non-smokers in a range of PM paradigms from self-reported PM, laboratory-based methods, through to real-world measures. In addition, previous smokers will be included in order to establish whether smoking cessation leads to improvements in PM performance. Therefore, the first aspect of the current thesis was to consider what impact prolonged smoking might have upon everyday PM. The second aspect offers an opportunity to gain an insight into whether smoking cessation leads to some recovery in PM, which may have educational value to those who have a wish to stop smoking.

Chapter 2:

Study 1: A comparison of smokers, non-smokers and previous smokers on self-reports of PM and a PRVP test.

2.1 Introduction

At the commencement of this study the only published research on the effects of smoking and PM was that completed by Heffernan et al in 2005. Heffernan et al

found that, after statistically controlling for other drug use and strategy use, smokers reported a greater number of long-term PM errors than non-smokers, and heavy smokers reported more lapses than light smokers suggesting a dose-dependent impact upon long-term PM performance. These findings were taken as suggesting that there are selective memory deficits associated with smoking and that long-term PM deficits should be added to the growing list of memory problems associated with cigarette use. This may be an important finding that needed replication. It is equally important to establish whether such PM deficits associated with smoking extend to objective measures of PM in order to verify whether such deficits extend to an objective measure of PM.

Study 1 attempted to replicate the long-term PM deficit found by Heffernan et al (2005) using the Prospective Memory Questionnaire (PMQ), controlling for other drug use, age, and strategy use. The second aim of the study was to extend the focus in order to observe whether such deficits were evident when utilising an objective measure in the form of the Prospective Remembering Video Procedure (PRVP) (based on Forster, 2003). Since Heffernan et al did not include people who have stopped smoking, the third aim of the present study was to observe whether those who had stopped smoking would show any recovery in PM functioning. Although Heffernan et al did not include previous smokers there is evidence from other research paradigms that show superior cognitive performance in previous smokers when compared to current smokers. For example, Kalmijn et al., 2002 found that current smokers scored significantly worse than non-smokers and previous smokers on the verbal learning test and on the Stroop Colour Word test, with the previous

smokers falling in between non-smokers and smokers. In addition, Sabia et al 2008 conducted a longitudinal study which showed that those who stopped smoking from one decade to the next had a lower risk of poorer cognition than those who continued to smoke, as well as when being compared to non-smokers. Finally, Fried et al 2006 showed that former smokers outperformed current smokers on a series of mental arithmetical tasks. Therefore, it is feasible that the cessation of smoking leads to improved cognitive performance and the current study observes whether such improvements extend to PM function.

The study included a broad spectrum of age ranges in order to access as wide a representative sample across the age range as possible. Based on Heffernan et al (2005) it is expected that smokers will report more self-reported long-term PM deficits than non-smokers, but no firm hypothesis can be postulated about whether such deficits extend to an objective measure of PM in terms of performance on the PRVP. Since previous research in this area has not included previous smokers no firm predictions can be made about this group. Age, strategy use and other drug use will be incorporated into the analysis as covariates.

Rationale for Methodology Adopted.

Study 1 adopted the Prospective and Retrospective Video Procedure (PRVP) as an objective measure of PM which requires the person to remember particular actions at different locations as they watch a 10 minute video clip of a busy shopping scene (based on Forster, 2003). The rationale for adopting the PRVP as a method of testing PM came from a number of sources. Firstly, the notion of using video-based PM tasks was suggested by recent research and thinking in the field (Titov & Knight,

2001; Bartholomew et al., in press). Secondly, it was a measure that had been used previously within the field (e.g. Forster, 2003; Seed et al., 2005). Finally, no standardised published objective measure of PM was available within the university when the current project began in January 2006. The Prospective Memory Questionnaire was adopted as a self-report of PM (Hannon et al., 1995) and was adopted in order to attempt to replicate the long-term PM deficit found by Heffernan et al (2005) who also used the PMQ in their study. Age, strategy use and other drug use (including alcohol, cannabis and ecstasy) were also measured and incorporated into the main analysis as covariates because it has been argued that these factors have an adverse affect upon memory as discussed by Heffernan et al (2005). Gender was included since research has demonstrated gender-related differences in PM (Rodgers et al., 2003).

2.2 Method

Design

The present study employed a non-experimental, existing-groups design. There was one independent factor which had 3 levels: smokers, non-smokers and previous smokers. Four main dependent measures were assessed. The self-reported PM scores achieved on the Prospective Memory Questionnaire (PMQ: Hannon, et al., 1995) subscales for (1) long-term PM (LTPM), (2) short-term PM (STPM), (3) internally cued PM (ICPM), and (4) the total score on the Prospective Remembering Video Procedure (PRVP). In addition there were seven non-memory covariates: age (1), gender (2), Drug use characteristics, comprising alcohol use in weekly units (3), cannabis use in joints per week (4), and ecstasy (MDMA) use in number of tablets

per week (5), and other drug use (yes/no answer) (6), and strategy use (7). Cigarette characteristics (e.g. the number of cigarettes smoked per week) were used only to distinguish the 3 groups and not used as covariates in the main analysis. Covariation was applied to control for any differences between the smokers, previous smokers and non-smokers on a range of non-memory measures (i.e. age, alcohol use, cannabis use, ecstasy use and other drug use, as well as any strategies employed). An additional control measure was the fact that the order in which the tests were administered remained constant across all the participants tested.

Participants

A total of 208 people (113 males and 95 females) took part in the study having been recruited from the general public, the student population and North East Age Research centre at Northumbria University, in Newcastle-upon-Tyne. The older participants had mixed educational/professional background, the middle-aged participants were composed of professionally qualified people, and the younger participants were all university undergraduates. All the participants were volunteers. There were three groups compared; smokers (N=68: 40 males), non-smokers (N=89: 51 males) and previous smokers (N=51: 21 males). The mean age of the smokers was 42 years (SD=23.1), they smoked on average 71.6 cigarettes per week (SD=55.4), with a range of between 5 and 150 cigarettes per week (with the most frequently occurring number being 100 cigarettes per week) and had smoked for an average of 21.6 years (SD=19.7). For the non-smokers their mean age was 39.7 years (SD=25.9). For previous smokers their mean age was 44.2 years (SD=20.9). All participants were recruited using an opportunity sampling method.

Materials

The Recreational Drug Behaviour Questionnaire (RDBQ)

The RDBQ measured smoking and other substance use. The RDBQ is a self-assessed questionnaire that requires participants to record the number of cigarettes smoked during each week, the amount of alcohol in units per week, the amount of ecstasy (number of tablets taken) used each week, and cannabis (number of joints smoked) used per week. The questionnaire also allowed the person to record any other substances used. In addition, the RDBQ also asked the participants to note the length of time they had been taking the drugs, as well as sex and age details. The RDBQ was a modified version of that used by Heffernan et al., 2005. (See Appendix 1 for example of the RDBQ).

The Prospective Memory Questionnaire (PMQ)

Prospective memory was measured using the PMQ, which was devised by Hannon et al (1995). The scale compares well with other measures of prospective remembering and has high test-retest reliability ($r = 0.88$), as well high internal validity ($r = 0.76$), (see Hannon et al., 1995). The questions themselves are relatively simple and easy to respond to. An example is – "I forgot to water my plants." The response would be placed on a line segregated by nine vertical marks, a nine point Likert scale, each indicating a level of forgetfulness from Never (1) to 4 or more times/month (9). The questionnaire is split into four sub-scales (i.e. long-term episodic, short-term habitual and internally-cued prospective memory). The fourth

of these sub-scales provides participants answers on the number of strategies used by them to aid remembering. (See Appendix 2 for example of the PMQ).

The following description provides details of the above-mentioned sub-scales:-

<u>Long-term Episodic Sub-scales</u> (Questions 1-14 inclusive)

This seeks responses to those questions that are expected to be completed sometime following the cue for its performance on tasks that occur on an irregular basis (i.e. "I forgot to make an important telephone call.")

<u>Short-term Habitual Sub-scale</u> (questions 15-28 inclusive)

In this scale the task is expected to be completed very soon following the cue to perform it and these questions concern most tasks that can occur more routinely (e.g. "I forgot to lock up my house, bike, or car.")

<u>Internally-cued Sub-scale</u> (questions 29-38 inclusive)

Questions in this scale are used where a task does not possess clear external cues (e.g. "I forgot what I came into a room to get.")

<u>Strategies for Remembering Sub-scale</u> (questions 39-52 inclusive)

This scale comprises those techniques that are used to help a person to remember to carry out a prospective memory task (e.g. "I make post-it (sticky notes) reminders and place them in obvious places.")

The PMQ is scored by totalling the number of notches circled/slashed in from the left of the scale (i.e. from 1 to 9 for each question), total the number of scales points for that particular subscale and dividing that by total number of questions answered for that sub-scale, providing a mean PM score per sub-scale. Where a question is not applicable (N/A) then this question is not included in the scoring. For the long-term, short-term and internally-cued prospective memory scales, the higher the score the greater the number of errors reported in prospective memory. In the case of the strategy scale, the higher the score the greater the number of strategies used to aid remembering (See Hannon et al., 1995).

The Prospective Remembering Video Procedure (PRVP)

The Prospective Memory Video Procedure (PRVP) - (based on Forster, 2003) was presented on a CD-ROM and represents a 10 minute video sequence of a walk through a main shopping area in Scarborough. The video focuses on shop fronts and everyday locations (e.g a telephone stall, people shopping) and actions/items associated with those locations. It shows a variety of shops, people shopping, children playing, in fact all aspects of everyday street life and communication. It is the inclusion of these everyday items that ensures the task has high face validity (because it includes things that people do naturally) and ecological validity (i.e. it involves activities that are done in a natural setting). Earlier studies have shown that using both 'doing' (actions) and 'question' items in these type of questionnaires makes the tasks more complex and lessens the possibilities of ceiling/floor effects (Titov & Knight, 2001). There were 21 Location – Action combinations (for example, "At the Halifax" (location) – "Check if loan has cleared" (action) would be

one such combination). (See Appendix 3 for list of items). 1 point was given for each correct Location – Action combination correctly recalled, with a possible total of 21 points achievable. The higher the score, the better one's PM was presumed to be.

The PRVP was deemed to have face validity in that its aim was to test a person's ability to remember to do particular activities at particular locations on a video-clip of a busy shopping area in Scarborough, thus tapping into everyday PM. Concurrent validity of the PRVP was established by demonstrating a significant negative correlation between the scores on the PRVP and the total PM scores on the PMQ [r(55)=-0.35, p<.01] indicating that the higher the scores on the PRVP, the less errors were reported on the PMQ. In order to demonstrate the PRVP's reliability, a split-half reliability test was conducted on the first half scores (using items 1 – 10) and the second half score (items 11 – 21) on the PRVP results on a random sample of 55 participants from the entire study population. The results of the split-half reliability check showed good reliability [r(55)=0.43, p<.001]. The figure in brackets represents the up-to-date SPSS method of calculation that is based on the total number of participants used in the sample rather than the older statistic that used the degrees of freedom (Kinnear & Gray, 2008).

Procedure

Ethical approval for the study was provided by the Staff Ethics Committee of the School of Psychology and Sport Sciences at Northumbria University indicating that the approval adhered to the British Psychological Society's ethical guidelines. Approval to approach those aged over 60 years was obtained from the North East Aged Research (NEAR). For the older group, a letter from the University confirming

the identity of the student conducting the study and its purpose, along with an Information for Participant Form and postal Consent Form was posted to each person shown on the North East Age Research (NEAR) (based at Northumbria University) register and taken to two residential homes in Newcastle. At the time of attendance all other participants were provided with the Information for Participant Form and Consent Form. On each of these forms a smoker, previous smoker and non-smoker category was provided so that the participant could be identified as one of these groups. The Information for Participant Form provided details of the title and aims of the study, the criteria for inclusion, brief details of what each participant would be expected to do during the procedure, their right to withdraw at any time during or after participation and an ID code unique to each participant that would ensure confidentiality on data forms and which could be used to withdraw their data at any time. The Consent Form provided the title of the study and requested a signature of consent and identified their ID code.

After consenting to participate in the study, each participant was then provided with the response pack containing the Recreational Drug Behaviour Questionnaire (RDBQ), the Prospective Memory Questionnaire (PMQ) and the Prospective Remembering Video Procedure (PRVP) instructions and the PRVP Response Sheet. This had an ID code on the front of the pack to maintain confidentiality. Each participant was required to read the Instructions to Participant sheet first and was then presented with a copy of the PRVP score sheet with the latter turned facedown. For the PRVP the participant was told that he/she should only respond when they reached the particular location on the video and not to just write down as many

combinations as they could at the beginning. They were asked if they understood what was expected of them, provided with an example if needed, and any questions were answered. They were then requested to turn over the PRVP Score sheet and given 2 minutes to read and remember the 21 Location-Action details. The PRVP score sheet was then returned to the researcher after the two-minute period. Before carrying out the PRVP, each participant was required to complete the RDBQ and PMQ questionnaires.

Following this they were presented with the PRVP response sheet and reminded that they were expected to write the correct location and action/response on the response sheet when watching the video clip, but only when they reached the particular location they recognised from the list previously presented. The researcher observed to ensure that the participant only responded when a particular location was reached on the video. The Response sheets were then collected for marking. Each response sheet was marked according to the marking procedures outlined in the Materials Section. Following completion of the PRVP each participant was thanked for their participation and given a copy of the Debriefing Sheet. Again they were reminded of their right to have their data withdrawn from the study at any time by providing their ID code. Participants were advised that feedback, in the form of overall findings, could be sought by contacting the researcher after March, 2007. The whole testing time took approximately 45 minutes per participant and the participants were tested in small groups (with at least a 1 seat/desk gap between each participant) in a quiet laboratory setting.

2.3 Results

The results were collated into SPSS (version 12). The data was analysed across the three levels of smoking condition as the independent factor: smokers, non-smokers and previous smokers. The tables below present the means and standard deviations from the covariates (Table 2.1) and the data from the PMQ (Table 2.2).

Table 2.1 Means and Standard Deviations for non-memory measures of age, weekly units of alcohol, number of cannabis joints per week, number of ecstasy tablets used per week, and number of strategies used reported by smokers, non-smokers and previous smokers.

Conditions		Age	Units of alcohol	Cannabis per week	Ecstasy per week	strategy score
Smoker	Mean	42.0	11.07	.21	.04	3.82
	N	68	68	68	68	68
	Std. Devn	23.1	12.3	.83	.27	1.70
non-smoker	Mean	39.7	9.55	.16	.00	4.21
	N	89	89	89	89	89
	Std. Devn	25.9	10.3	1.27	.00	1.56
previous	Mean	44.1	13.1	.00	.00	3.67
	N	51	51	51	51	51
	Std. Devn	20.9	12.9	.00	.00	1.43

	Age	Gender	Units of alcohol	Cannabis per week	Ecstasy per week	Other Drugs	Strategy score

Table 2.2 Means and Standard Deviations for the main memory measures- Long-term PM (LTPM), Short-term PM (STPM) and Internally-cued PM (ICPM) reported by smokers, non-smokers and previous smokers.

		long-term PM	short-term PM	internally-cued PM
Smoker	Mean	2.75	1.52	2.98
	N	68	68	68
	Std. Devn	1.33	0.45	1.32
Non-smoker	Mean	2.58	1.48	3.08
	N	89	89	89
	Std. Devn	0.94	0.43	1.1
Previous	Mean	1.96	1.53	2.38
	N	51	51	51
	Std. Devn	0.73	0.44	1.22

2.3

presents

LTPM	P<.01	NS	P<.05	NS	NS	NS	P<.001
STPM	NS	NS	P<.05	NS	NS	NS	NS
ICPM	NS	NS	NS	P<.05	NS	NS	P<.05
PRVP	P<.001	NS	NS	P<.05	NS	NS	NS

Table

below

the

relationship between age, gender, units of alcohol used per week, cannabis use per week, ecstasy use per week, other drug use, and strategy scores, and the main independent measures (i.e. scores on the LTPM, STPM, ICPM and PRVP).

Table 2.3 Shows the p values for the relationship between each covariate and each of the dependent PM measures controlled for in the main series of ANCOVAs that follow.

It was decided to adopt an ultra-conservative approach to control for any variations across the 3 conditions (smokers, non-smokers and previous smokers) on the covariates on the basis that previous research has indicated that these factors can have a significant impact upon memory per se (see Introduction). This meant that all of the covariates were incorporated into the ANCOVAs, regardless of whether they were significantly related to the dependent measures or not.

Figure 2.1 below contains the means and standard deviations for the Prospective Remembering Video Procedure (PRVP).
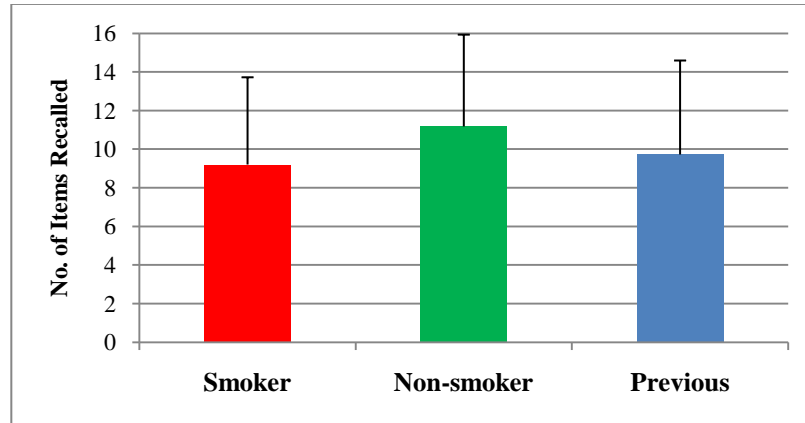
Figure 2.1 Means and Standard Deviations for the scores on the Prospective Remembering Video Procedure (PRVP) comparing smokers, non-smokers and previous smokers.

A series of One-Way Analysis of Co-Variances (ANCOVAs: incorporating age, gender, alcohol use, cannabis use, ecstasy use, other drug use (Yes/No) and strategy use as covariates) and Pairwise Comparisons (with Bonferroni corrections) were applied to the data for smoking condition (non-smokers, smokers and previous smokers) on each of the memory measures (i.e. LTPM, STPM, ICPM and PRVP (Video) scores). These revealed the following.

For LTPM there was a main effect of smoking condition [$F_{(2, 198)} = 9.71$, $p<.001$]. Pairwise comparisons revealed that the previous smoking group (Mean = 1.96) reported fewer errors than smokers (Mean = 2.75) ($p<.05$) and than non smokers (Mean = 2.58) ($p<.05$), with no significant difference between non-smokers and smokers ($p>.05$).

For STPM there was no main effect of smoking condition [F(2, 198) = 0.19, p=.82]. Since there is no main effect, no Pairwise comparisons were computed.

For ICPM there was a main effect of smoking condition [F(2, 198) = 4.92, p<.01]. Pairwise comparisons revealed that the previous smoking group (Mean = 2.37) reported fewer errors than smokers (Mean = 2.98) (p<.05) and non smokers (Mean = 3.08) (p<.05), with no significant difference between non-smokers and smokers (p>.05).

For PRVP there was a main effect of smoking condition [F(2, 198) = 3.28, p<.05]. Pairwise comparisons revealed that non-smokers (Mean = 11.1 items recalled) recalled more items than smokers (Mean = 9.2 items recalled) (p<.05), with no difference between the previous smoking group (Mean = 9.73 items recalled) and non-smokers (p>.05), nor between the previous smoking group and smokers (p>.05). The previous smoking group appear to fall between the two other groups in terms of their PRVP performance.

Correlational Analyses.

In addition to the main analyses three sets of correlations were carried out: one that assessed the association between the number of cigarettes smoked and the self-reported and objective measures of PM, a second set that assessed the association between how long the person had smoked and the self-reported and objective measures of PM and a third set that assessed the association between the lifetime usage of cigarettes (calculated as the number of cigarettes smoked per week x the

number of years smoked) and the self-reported and objective measures of PM across all current smokers from the study. The purpose of these correlational analyses was to observe whether the number of cigarettes smoked, how long the person had been smoking and lifetime cigarette use in the current smokers was associated with a particular pattern of memory lapses on the LTPM, STPM, ICPM sub-scales and recall on the PRVP.

A set of Pearson Product Moment correlations was applied to the data to assess the association between the number of cigarettes smoked and the self-reported and objective measures of PM. This revealed no significant correlation between the number of cigarettes smoked and LTPM scores ($r(68)=-0.06$, $p=.60$), no significant correlation between the number of cigarettes smoked and STPM scores ($r(68)=-0.004$, $p=.97$), no significant correlation between the number of cigarettes smoked and ICPM scores ($r(68)=-0.13$, $p=.29$), and no significant correlation between the number of cigarettes smoked and PRVP scores ($r(68)=-.19$, $p=.10$).

A set of Pearson Product Moment correlations was applied to the data to assess the association between the how long the person had smoked and the self-reported and objective measures of PM. This revealed no significant correlation between the length of time they had smoked and STPM scores ($r(68)=-0.02$, $p=.85$), no significant correlation between the length of time they had smoked and ICPM scores ($r(68)=-0.15$, $p=.20$), but there was a significant negative correlation between the length of time they had smoked and LTPM scores ($r(68)=-0.56$, $p<.001$) indicating that the longer one has smoked the less lapses the person reported, and a significant

negative correlation between the length of time they had smoked and PRVP scores (r(68)=-0.51, p<.001) indicating the greater the length of time the person had smoked the worse their performance was on the PRVP. The scatterplot for the significant relationship between the length of time they had smoked and the LTPM scores appears in Figure 2.2 below and the scatterplot for the significant relationship between the length of time they had smoked and the PRVP scores appears in Figure 2.3 below.
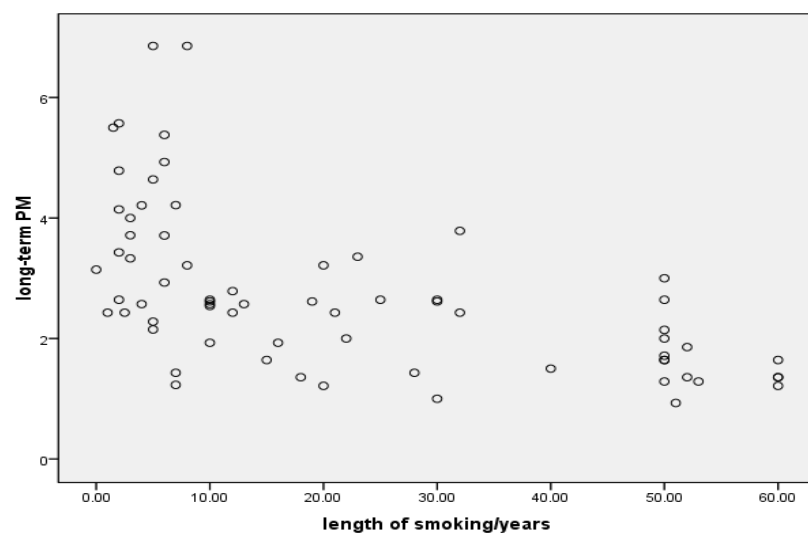
Figure 2.2 A significant negative correlation between the length of time they had smoked and scores on the LTPM, indicating that the longer they had smoked the less lapses the person reported on the LTPM.
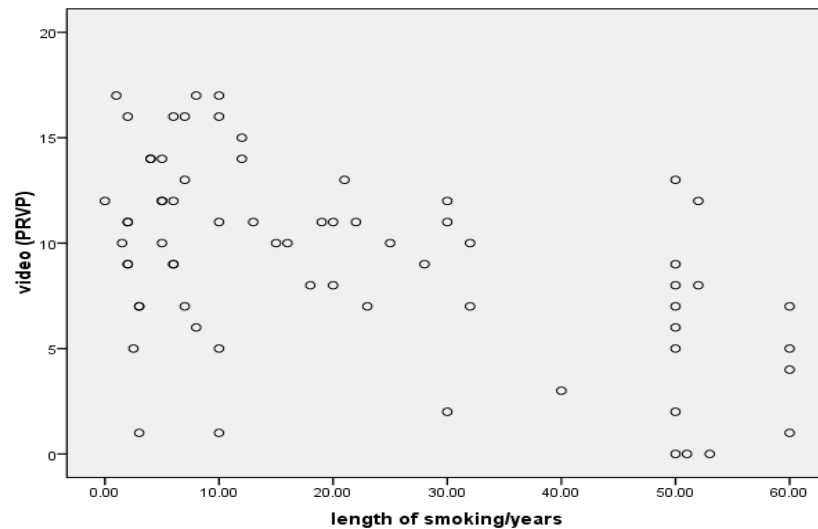
Figure 2.3 A significant negative correlation between the length of time they had smoked and scores on the PRVP, indicating that the longer they had smoked the worse their performance was on the PRVP.

A set of Pearson Product Moment correlations was applied to the data to assess the association between lifetime usage of cigarettes in smokers and the self-reported and objective measures of PM. This revealed a significant negative correlation between lifetime use of cigarettes and LTPM ($r(68)=-0.42$, $p<.001$) – which indicates that the greater the lifetime usage the less lapses are reported on LTPM. A partial correlation revealed that when the number of cigarettes were controlled for, the correlation between lifetime usage and scores on the LTPM remained significant ($r(65)=-0.52$, $p<.001$) whereas when the length of smoking was controlled for the correlation between lifetime usage and scores on the LTPM became non-significant ($r(65)=-0.007$, $p=.95$). There was also a significant negative correlation between lifetime use of cigarettes and scores on the ICPM ($r(68)=-0.24$, $p<.05$) – which indicates that the greater the lifetime usage the less lapses are reported on ICPM. A partial correlation revealed that when the number of cigarettes were controlled for, the correlation between lifetime usage and scores on the ICPM remained significant

73

(r(65)=-0.24, p<.05) whereas when the length of smoking was controlled for the correlation between lifetime usage and scores on the ICPM became non-significant (r(65)=-0.19 p=.13). Both of these findings indicate that the length of smoking is the important contributor to the overall correlations between lifetime usage and LTPM and ICPM scores. However, given that the correlations were negative these findings suggest that the greater the lifetime usage the fewer PM lapses were experienced. There was no significant correlation between lifetime use of cigarettes and STPM (r(68)=0.01, p=.89).

Finally, there was a significant negative correlation between lifetime use of cigarettes and scores on the PRVP (r(68)=-41, p<.001) – which indicates that the greater the lifetime usage the fewer items recalled on the PRVP. A partial correlation revealed that when the number of cigarettes were controlled for the correlation between lifetime usage and scores on the PRVP remained significant (r(65)=-0.39, p<.001) whereas when the length of smoking was controlled for the correlation between lifetime usage and scores on the PRVP became non-significant (r(65)=-0.05 p=.63). Both of these findings indicate that the length of smoking is the important contributor to the overall correlations between lifetime usage and PRVP scores. The scatterplots for the significant correlations between lifetime usage of cigarettes and scores on the LTPM, ICPM and PRVP are presented below (see Figures 2.4, 2.5 and 2.6 respectively).
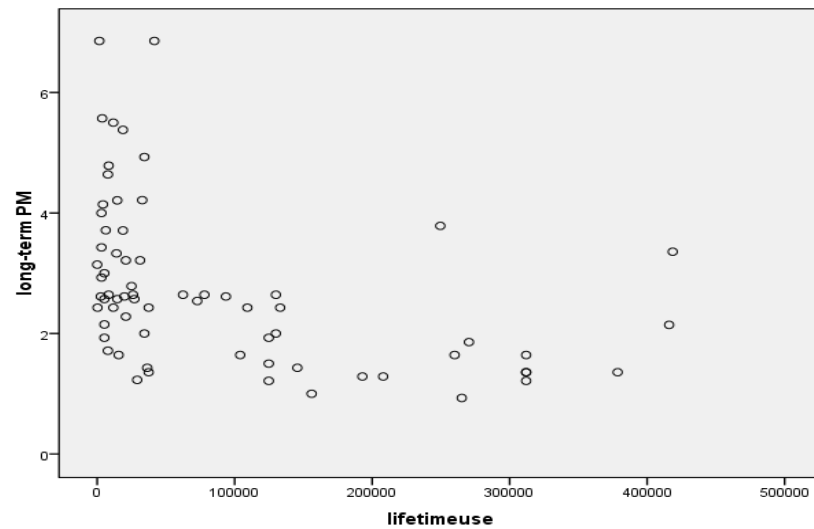
Figure 2.4 A significant negative correlation between lifetime usage of cigarettes and scores on the LTPM, indicating that the greater the lifetime usage the less lapses they report on the LTPM.
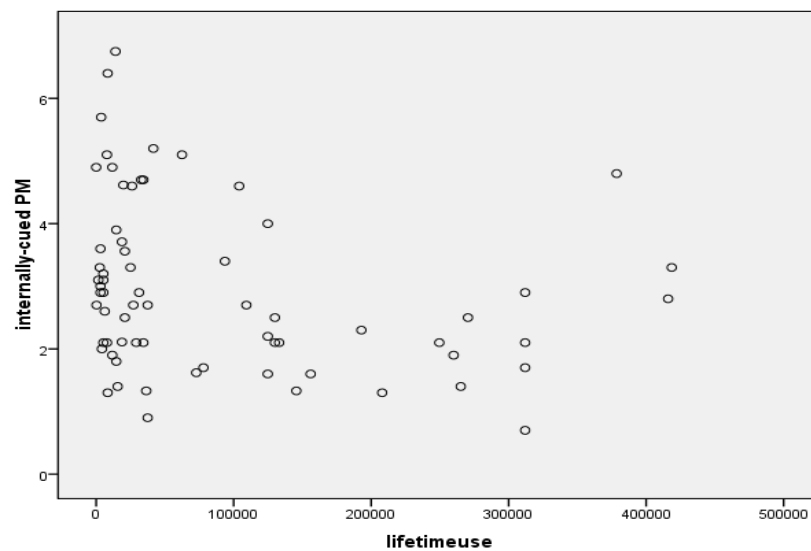
Figure 2.5 A significant negative correlation between lifetime usage of cigarettes and scores on the ICPM, indicating that the greater the lifetime usage less lapses they report on the ICPM.
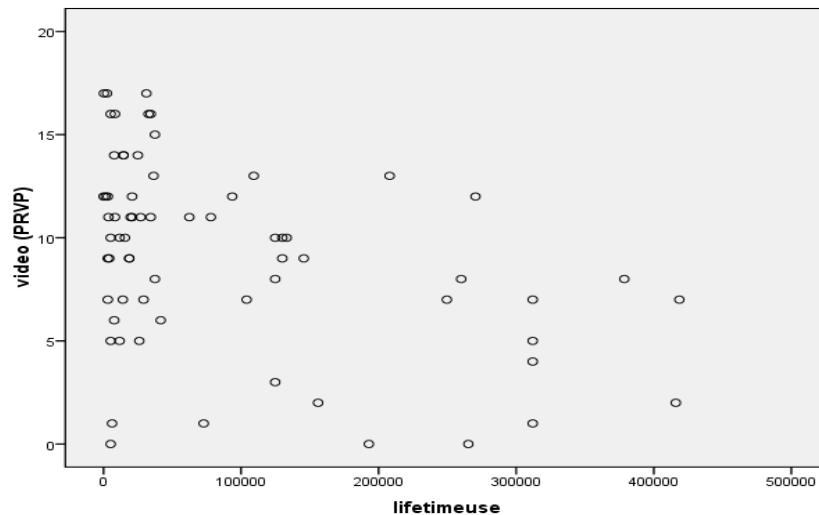
Figure 2.6 A significant negative correlation between lifetime usage of cigarettes and scores on the PRVP, indicating that the greater the lifetime usage the worse their performance on the PRVP (i.e. the worse their PM).

2.4 Discussion

There were three aims of Study 1. Firstly, to try to replicate the LTPM deficits reported by smokers on the self-reported PMQ as found by Heffernan et al (2005), for example, forgetting to post a letter on time, to meet with friends, and so on. Secondly, to observe whether such deficits extend to an objective measure in the form of the Prospective Remembering Video Procedure (PRVP) (based on Forster, 2003). Thirdly, to observe whether those who have stopped smoking (previous smokers) show recovery in function of PM compared with the two other groups. Any between-group differences on age, strategy use and other drug use were measured and incorporated into the analysis as covariates.

The results from the self-report PMQ data revealed an unusual pattern of findings. With regards to the self-reports of PM, the previous smokers group reported significantly less lapses than smokers or non-smokers, with no difference between

the two latter groups on the LTPM and ICPM measures. However for the STPM there was no significant difference between the groups. From the results of the PRVP it is clear that both previous smokers and non-smokers performed significantly better than smokers, with no significant difference in performance between the previous and non-smoking groups. The previous smoking group appear to fall between the two other groups in terms of their PRVP performance. In addition, correlations on the current smokers only revealed that the lifetime usage of cigarettes in current smokers was negatively correlated with scores on the LTPM, ICPM and PRVP.

The findings revealed that for the LTPM and ICPM sub-scales previous smokers reported significantly fewer self-reported lapses than smokers and non-smokers – with no differences between the latter groups. The pattern of self-reported memory lapses found in the present study is different to that found by Heffernan et al (2005). For the LTPM no significant difference was found between non-smokers and smokers in the present study, which is inconsistent with Heffernan et al who found that smokers reported more memory lapses than non-smokers on this measure. The finding that previous smokers reported less LTPM and ICPM lapses than the other two groups suggest that cessation leads to improvements in PM. Since Heffernan et al did not include previous smokers this is a new finding in the literature.

The results from the correlational analyses applied to the smokers produced mixed findings. There was no relationship between the number of cigarettes used per week and any of the PM measures. Secondly, the length of smoking in years was negatively correlated with the LTPM and PRVP scores, suggesting that the longer

one has been smoking the fewer the memory lapses reported on the LTPM, but that the longer one had smoked the less items were recalled on the PRVP. In addition, lifetime usage was negatively correlated with scores on the LTPM and ICPM both of which suggests that the more smokers have smoked across their lifetime, the less memory problems they experienced. Finally, lifetime usage was also negatively correlated to PRVP scores indicating the greater the life time usage the poorer the performance on the PRVP. The partial correlations suggested that it was the length of time smoking (and not the number of cigarettes smoked) that was the main contributor to the relationship between lifetime usage and scores on the ICPM, LTPM and PRVP scores, rather than the number of cigarettes smoked per week

The findings from the LTPM and ICPM are inconsistent with the notion that smoking has a detrimental effect on one's memory and is inconsistent with the findings from Heffernan et al., (2005). It should also be noted that in the older participants (41% of the smokers in the present study), based on looking at the raw data, many of them reported having had better memories than younger participants, which is unusual. It is feasible that given that older people may be more prone to overestimating their memory performance (see e.g. Baddeley, 1999) that this has led to a serious confound on the self-reported memory measures in the present study. The PRVP was related to the length of smoking and lifetime usage, suggesting that the longer one had smoked the poorer their PM on the objective measure. The failure to find any relationship between the number of cigarettes used per week and PM suggest that smoking related PM impairments is not dose-related, rather it is the length of time one has smoked that is the better predictor of variations in PM

performance. It is argued here that the PRVP provides a more objective measure of the participants' performance and therefore provides a clearer reflection of performance with regards years spent smoking and lifetime usage of cigarettes and PM function. However, it should be noted that correlations between factors does not imply a causal relationship and does not allow one to judge whether any particular method (e.g. the utilisation of the PMQ or PRVP in the present study) is preferable to another method of measuring PM. The implications of these findings are considered in more depth in the General Discussion section.

The inclusion of the PRVP in this study is a novel aspect (since Heffernan et al. was based on self-reported PM alone) and the fact that smokers perform worse on the PRVP is a new finding in the literature on smoking and its impact upon PM. From this it appears that smoking has a detrimental effect upon PM when one compares smokers with non-smokers. But it should be noted that this is only evident from the results of the PRVP and not from the findings of the self-reports - suggesting a note of caution when interpreting these findings beyond the thesis. With regards to the previous smokers, who appear to fall between the other two groups, it is suggested that there may be some recovery of PM functioning as a result of ceasing from smoking, but not sufficiently to produce a full recovery of memory performance (which is why they also do not significantly differ from smokers on the PRVP), but again a note of caution is needed given the mixed findings from the self-reports. Since the objective PRVP measure is not subject to the types of biases associated with self-reports it is suggested here that this is the more reliable of the measures in the present study. From the findings of the present study it appears that poorer PM

performance is associated with a history of smoking and the findings are consistent with the notion that smoking may impair memory.

With regards putative explanations of the poorer PRVP performance in smokers when compared to non-smokers, two potential theories are offered here. Previous research suggests that smoking nicotine can have an enhancing effect of simple retrospective memory recall tasks (Rusted et al., 1998; Warburton et al., 2000). Similar benefits have been found on PM tasks, for example, PM enhancement is found under relatively simple task conditions (e.g. Rusted & Trawley, 2006; Rash, 2007) where simple key-pressing activity is associated with seeing a word appear on a screen. These enhancing effects are often associated with an increase in physiological arousal levels in smokers who have ingested nicotine, which in turn leads to enhanced memory recall. However, when more demanding tasks are included, for example, where the task requires memory + ongoing monitoring + reacting to cues in the environment + recall from memory, smoking nicotine does not appear to be an enhancer for PM and decrements in PM are observed (see e.g. Rash, 2007). Therefore the diminished performance in smokers on the PRVP task is explicable in terms of the relatively high task demands involved in the PRVP (which required the participant to memorise a series of location-action combinations, monitor the ongoing shopping scenario as the video clip commenced, identify a cue in terms of an event within the video clip, and recall each location-action combination). It is argued here that it is the high task demands that smokers find more difficult to achieve and that smoking nicotine therefore loses its advantages given the complexity of the task (i.e. the PRVP). It appears therefore that when task

demands are high the combination of nicotine-induced arousal and increased arousal due to the high task demands may lead to a state of over-arousal that can induce decrements in cognitive performance – a type of 'inverted U' effect of arousal (as expounded by Rash, 2007). Thus a 'task demand' explanation is feasible. One would not expect the same task demand hypothesis to apply to the self-reported PM data since this is retrospective in nature and often asks questions which are from some time ago and therefore not affected by one's present state.

Within a PM framework, the Multi-Process Model of PM (McDaniel & Einstein, 2007) could also explain the findings from the present study. Given the complexity of the PRVP (outlined above), its high task demands would require more effortful processing than simple cue-response scenarios (which might rely more on automatic processing). It is therefore feasible that smokers find the high task demands involved in the PRVP more taxing than non-smokers and previous smokers. It is possible that the effortful processing interacts with increased arousal levels leads to decrements in PM performance, as discussed earlier.

A third potential explanation comes from the notion that smoking interferes with oxygen being carried to the brain. Human haemoglobin has a much greater affinity for carbon monoxide (CO) than for oxygen, therefore, inhaling tobacco smoke with a high level of CO diminishes the oxygen carrying capacity of the blood which can deprive the brain of oxygen (Parrott et al, 2004). CO poisoning has been found to impair cognitive function in those who have survived such poisoning, resulting in a range of cognitive declines including attentional difficulties and deficits in executive

function (Hopkins & Woon, 2006). It is feasible that prolonged smoking would deprive the brain of oxygen over a period of time and that this oxygen deprivation leads to deficits in PM functioning in smokers, thus explaining their poorer PM performance in the present study. This model is somewhat speculative but does have logical appeal as an explanation for the decrements and improvements observed in the present thesis. This explanation does not explain the very mixed findings associated with the self-reports of PM reported in this thesis.

The fact that the previous smokers fell between the non-smokers and smokers in their performance on the PRVP can also be explained by either/both the previous theories. It is feasible that previous smokers no longer experience the 'over-arousal' that might result from the combined effect of nicotine ingestion and high task demands, therefore showing improved performance on the PRVP task. It is also possible that the cessation from smoking leads to improved oxygen flow to the brain and therefore improved cognitive function, including PM performance.

The precise mechanisms that might be damaged by persistent smoking are at present not fully understood. However, since it has been postulated that prospective memory involves activation of prefrontal cortex (e.g. McFarland & Glisky, 2009), as well as the medial temporal lobes (e.g. Kliegel, McDaniel and Einstein, 2008,), it is feasible that putative damage could be to either or both of these areas. This is considered further in the general discussion section towards the end of the thesis.

There were a number of limitations with Study 1 that need improving upon. Firstly, the PMQ is a self-report measure of everyday PM lapses. Although the measure has been validated by Hannon et al (1995), the authors themselves acknowledge that the PMQ does not correlate well with a number of other objective measures of PM used in the study. For example, the correlation between the long-term PM subscale was only weakly correlated with an actual PM task in which the participants were asked to return a number of questionnaires at a later time (r(141) =-.06, p=ns), nor correlated with the participants being asked to place their name and the current date on the questionnaire before returning them (r(141) =.01, p=ns), neither was the total PM score from the PMQ correlated with these two long-term examples of PM (r(141) =.01, p=ns and r(141) =.07, p=ns) respectively. In addition, recent work by Buchanan et al., (2005) has questioned its validity by demonstrating that not all the sub-scales load onto the construct known as PM.

Given these criticisms of the PMQ the following study will adopt a different and more recent self-report questionnaire in the form of a more recent scale known as the Prospective and Retrospective Memory Questionnaire (PRMQ: Crawford et al., 2003). It is an alternative self-report that measures long and short term PM and shows construct validity and good reliability (.83 for the PM component and .92 for the retrospective component). The PRMQ will be used in Study 2 as a measure of self-reported PM.

Secondly, research suggests that the mood of a person might have an impact upon their memory performance. For example, mood dependent memory is where

one recalls from memory more accurately when in the same mood state at retrieval as that at the storage stage (Eich, Macaulay & Ryan, 1994; Eich, 1995). Given that mood may affect memory and may interact with drug use upon cognition (Parrott et al., 1996; Parrott & Garnham, 1998; Parrott et al., 2004) this was also included in the present study as a covariate. Therefore Study 2 will attempt to control for this by including a mood measure in the form of the Hospital Anxiety and Depression Scale (HADS: Zigmund & Snaith, 1983).

Thirdly, it would clearly be prudent to control for variations in IQ, since this can impact upon memory capabilities. This is particularly so given the diverse range of educational backgrounds of the young, middle and older participants in the present study. Study 2 will therefore include a pre-morbid measure of IQ in the form of the National Adult Reading Test (NART: Nelson & Willison, 1991). The NART is a valid and reliable test that is a widely used measure of estimating pre-morbid ability in neuropsychological and clinical research (Crawford, Deary, Starr, & Whalley, 2001). The NART will be used in Study 2 for practical reasons, for example, it is easy to administer, it is user friendly and only requires the participant to pronounce a series of short words, thus reducing the time taken to complete the IQ test.

A fourth area of concern was the large standard deviation associated with the number of cigarettes smoked within the current smoker group (SD=55.4) which indicates a large variation in the amount smoked per week across the cohort. This ranged from very low to very high usage (from 2 – 150 cigarettes per week based on the raw data). This may be seen as introducing a possible confound in terms of

whether putative PM deficits are linked to cigarette usage per week – possibly a dose related impairment. However, based on the correlation between the number of cigarettes smoked per week and the PRVP scores reported in the results section, it was clear that no systematic relationship was observed between the number of cigarettes smoked per week and PRVP performance. Therefore it is concluded that the variation in cigarette use per week did not confound the findings on the PRVP in the present study.

A fifth area for concern was the wide age range of the participants in the present study (ranging from 18–92 years) which may have introduced a potential age bias across conditions. This may have confounded the results from the PRVP scores in that if the smoking group had a greater number of older people then it could be age per se that is causing the lower performance on the PRVP scores in this condition (smokers) when compared with the other conditions. The issue of a potential age bias across conditions was addressed by applying a univariate analysis of variance (ANOVA) on age as the dependent variable across the smokers, non-smokers and previous smokers, which revealed no significant age difference across these 3 conditions (F $(1, 205) = 0.57$, $p = 0.56$), and, in fact, there were more participants who were aged 60+ years in the non-smokers (N=27) than in the smokers (N=19) or in the previous smokers (N=12). It can be concluded from this that age differences between the conditions was not an issue in the present study. Although no age bias was found across the conditions in the present study, it would be preferable to reduce the age range to overcome potential biases associated with older people (such as the self-reported memory biases referred to earlier).

Finally, although the video-based PM measure (PRVP) has proven to be a reliable and ecologically valid tool for measuring everyday PM, it is important to provide convergent evidence from other objective measures of PM, therefore, Study 2 will utilise a valid and reliable measure of PM in the form of the Cambridge Prospective Memory Test (CAMPROMPT: Wilson et al., 2005) as a means of confirming the findings from the PRVP in the present study.

The overall conclusion from Study 1 is that persistent smoking is associated with greater impairments in PM performance and that the cessation of smoking may lead to some recovery in PM function. However, further confirmation is required and so these findings need replicating. Also, caution is needed before reaching any firm conclusion, for example, given the mixed findings from the self-reported PM measures and the fact that the PRVP measure is not a widely used measure of PM.

2.5 Chapter Summary

This study attempted to replicate the long-term PM deficit found by Heffernan et al (2005) using the Prospective Memory Questionnaire (PMQ). Secondly, the study aimed to extend the focus on whether such deficits are evident when using an objective measure in the form of the Prospective Remembering Video Procedure (PRVP). The third aim was to study whether those who had stopped smoking showed any recovery of function in PM. The self-reported PMQ data produced mixed findings, with previous users reporting significantly fewer lapses than the other two groups for LTPM and ICPM, with no difference on the STPM. Recent work by Buchanan et al., (2005) questioned the validity of the PMQ in terms of the STPM and ICPM sub-scales not producing consistent results, whereas the LTPM and strategy scales were found to produce consistent results across participants. The PRVP revealed that non-smokers recalled significantly more items than smokers. The previous smoker group fell between these two groups. These findings were observed after controlling for non-memory covariates. The difference between smokers and non-smokers on the PRVP supports the notion that PM deficits are associated with prolonged smoking and as previous smokers fell between the two groups may suggest some recovery of function, but not to the levels of the non-smokers' performance. The finding that non-smokers outperformed smokers on the PRVP is a novel finding in the literature and suggests persistent smoking is associated with greater impairments in PM performance. However, the causal nature of such an association is open to question. It was also shown that the longer current smokers had smoked and the greater their lifetime usage of cigarettes the worse their performance on the PRVP. However, there is a need for caution before reaching any

firm conclusion based on this finding, given that the self-reported PM measure (the scores on PMQ) showed very mixed results which were not consistent with previous research.

Chapter 3

Study 2: Comparing smokers, non-smokers and previous smokers on self-reports of PM and the CAMPROMPT.

3.1 Introduction

The findings from the self-reported PM measures taken from the PMQ produced mixed findings, with previous users reporting fewer lapses than the other two groups for LTPM and ICPM, but more lapses on the STPM. These findings were inconsistent with previous literature and do not support the hypothesis that self-reported deficits are associated with prolonged smoking (i.e. the long-term PM deficits observed by Heffernan et al., 2005). The main findings from the previous study was the observation that non-smokers recalled significantly more items than smokers on the PRVP, with previous smokers falling between these two groups.

The overall conclusion from Study 1 was that, based on the PRVP results, persistent smoking is associated with poorer PM performance and that previous smokers may experience some recovery in PM function. The fact that the study failed to replicate the long-term PM deficits in smokers observed in previous research throws doubt on the consistency of the PMQ as a means of detecting PM deficits across different cohorts. It should be noted that an association between persistent smoking and lower performance on the PRVP does not prove causality. These findings were revealed after controlling for age, gender, alcohol, cannabis, ecstasy and strategy use. The findings that smoking impairs PM performance and that smoking cessation can lead to improvements in PM performance on an objective

measure of PM may be important findings in the literature. However, there is a need for caution, given that the self-reported findings from the PMQ used in Study 1 produced inconsistent results which did not support previous research, as well as the fact that the PRVP was produced in-house and was not a standardised published test of PM.

There were a number of aspects raised in relation to Study 1 that need further focus. For example, given the problems identified in the previous study with regards to the integrity of the PMQ (see e.g. Hannon, et al., 1995), there is a need for further examination of the self-reported memory trends using another, more valid questionnaire. Secondly, given the potential importance of the findings from the PRVP it is essential that further confirmation of the findings from this objective measure be sought using a different, yet objective, measure of PM. Thirdly, there is a distinct requirement to narrow the age range from the extremely broad range used in Study 1. Fourthly, the design of the study was made more rigorous by incorporating further covariates in order to control for any between-group differences in mood and IQ.

Self-reported PM is measured by the Prospective and Retrospective Memory Questionnaire (PRMQ: Crawford et al., 2003), and the Cambridge Prospective Memory Test (CAMPROMPT: Wilson, Emslie, Foley, Shiel, et al., 2005) provided an objective measure of PM. The PRMQ has been tested for validity and reliability and is not subject to the criticisms raised in relation to the PMQ and is therefore preferred as a measure of self-reported PM in the present study. The CAMPROMPT

was used here as an attempt to confirm the findings from the PRVP using a new PM method not yet used in the present context. The advantage of using the CAMPROMPT is that it entails both event based and time based elements – which are typical of everyday use of PM – whereas the PRVP was event-based only. Mood is measured by the Hospital Anxiety and Depression Scale (HADS: Snaith and Zigmund, 1994) which provides a measure of depression and anxiety and pre-morbid IQ measured by the National Adult Reading Test (NART: Nelson & Willson, 1991), strategy use and drug use will be measured using the same questionnaires as was used in Study 1.

Given the mixed findings from the self-reported PM derived from the previous study, no specific predictions were made for the present study. The rationale for the inclusion of a self-report here was to establish, using a more reliable measure, whether any reliable pattern of effects emerge between smokers, non-smokers and previous smokers. Based on the findings from the PRVP measure in Study 1 it is predicted here that, if smoking does impair PM, then smokers – when compared to the non-smokers - should show deficits on the objective measure of PM. Based on the fact that previous smokers fell between the other two groups in their performance on the objective measure of PM in Study 1, no specific prediction was made with regards to this group.

Rationale for Methodology Adopted.

Study 2 adopted the Cambridge Prospective Memory Test (CAMPROMPT: Wilson, Emslie, Foley, Shiel, et al., 2005) as an objective measure of PM which measures time-

based and event-based prospective memory within a laboratory setting. This task is the only available standardised objective PM measure, which became available within the university after Study 1 was completed and was adopted in study 2 in order to attempt to confirm the findings from the PRVP and as a means of providing convergent evidence of any persistent PM deficits associated with smoking. Given the criticisms of the PMQ identified in the discussion section of Study 1, the present study adopted a more recent self-report questionnaire in the form of the Prospective and Retrospective Memory Questionnaire (PRMQ: Crawford et al., 2003) as an alternative self-report measure of long and short term PM and shows construct validity and good reliability. Age, gender, strategy use and other drug use (including alcohol, cannabis and ecstasy) were incorporated as covariates on the same grounds as discussed in Study 1. In addition, given that mood may affect PM and may interact with drug use upon cognition (Parrott et al., 1996; Parrott & Garnham, 1998; Parrott et al., 2004) this was also included in the present study as a covariate. Gender was also included as a covariate since research has demonstrated gender-related differences in PM (Rodgers et al., 2003), and IQ was measured and included due to the fact that IQ has been known to impact upon a range of neuropsychological measures, including memory (Diaz-Asper, Schretlen & Pearlson, 2004).

3.2 Method

Design

The present study employed a non-experimental, existing-groups design. There was one independent factor which had 3 levels: smokers, non-smokers and previous smokers. <u>Seven dependent measures</u> were assessed. The self-reported PM scores

achieved on the Prospective & Retrospective Memory Questionnaire (PRMQ: Crawford, et al., 2003) with subscales for (1) PM long-term (PMLT), (2) PM short-term (PMST), (3) retrospective memory long-term (RMLT) and (4) retrospective memory short-term (RMST). Note: RM sub-scales from the PRMQ were included here since it is part of the PRMQ and may provide some insight into this aspect of everyday remembering. There were three measures from the CAMPROMPT test-battery - event-based PM (5), time-based PM (6) and a total score on CAMPROMPT (7). <u>There were ten covariates measured:</u> age (1), gender (2), Drug use characteristics comprising alcohol use in weekly units (3), cannabis use in joints per week (4), and ecstasy (MDMA) use in terms of the number of tablets per week (5) and other drug use (Yes/No) (6). In addition mood was measured in the form of the HADS anxiety (7) and depression (8), the scores on the strategy scale taken from the PMQ (9) and a pre-morbid measure of IQ in the form of the NART scores (10). Cigarette characteristics (e.g. the number of cigarettes smoked per week) were used only to distinguish the 3 groups and not used as covariates in the main analysis.

Covariation would be used to control for any differences between the smokers, previous smokers and non-smokers on the non-memory covariates. As an additional control measure it was decided that the order in which the tests were administered would remain constant across all the participants tested. The first test to be used was the NART, followed by the CAMPROMPT, then the PRMQ tests, the drug questionnaire, the Hospital Anxiety and Depression Scale (HADS) questionnaire and finally, the strategy questionnaire.

Participants

A total of 78 people took part in the study. The mean age of the smokers was 24 years (SD=5.03, with 16 males and 15 females), they smoked on average 65.5 cigarettes per week (SD=38.8), with a range of between 10 and 160 cigarettes per week (with the most frequently occurring number being 70 cigarettes per week), had smoked for an average of 7.68 years (SD=5.84), and had last had a cigarette on average 3.71 hours previously (SD=9.49). For the non-smokers their average age was 22.3 years (SD=4.11, with 10 males and 21 females). For previous smokers their average age was 26.6 years (SD=5.6, with 6 males and 10 females), had been abstinent from smoking for an average of 23.5 months (SD=16.1). All participants were recruited using an opportunity sampling method and were all university undergraduates studying in the North East of England. All the participants were paid volunteers.

Materials

The National Adult Reading Test (NART)

The NART provides a measure of pre-morbid IQ (NART: Nelson & Willson, 1991). It is in the form of 50 cards. Each card has a single word on the page that the participant must read out aloud to the Researcher. This test is accompanied with a response sheet that has each of the 50 words listed on it. These words are taken from the Oxford English Dictionary some of which are more familiar and some that may be less familiar to the general public. Examples of the words used include Chord, Equivocal, Naïve, Gaoled, Zealot, Quadruped, Puerperal, and so on (See Nelson & Willson, 1991). The researcher checks the pronunciation of every word against the

correct pronunciation and 1 point is given to each word incorrectly pronounced. The total incorrectly pronounced is then deducted from the overall total of 50 and the total correctly pronounced represents their pre-morbid IQ score, with the higher the score the higher their IQ.

The Cambridge Prospective Memory Test (CAMPROMPT)

CAMPROMPT is a valid and reliable objective measure of PM (Wilson et al., 2005). Inter-rater reliability was high at 0.99 and a test-retest reliability revealed a significant correlation of 0.64 between first test and second test scores. Validity checks revealed significant correlations between total scores on CAMPROMPT and scores from the Rivermead Behavioural Memory Test for profile (r=0.38, p<.01) and screening (r=0.37, p<.01), as well a significant correlation between total scores on CAMPROMPT and scores from Modified Six Elements Test (r=0.42, p<.01).

The CAMPROMPT comprises of a pack containing: a large clock (complete with battery) which runs throughout the day, 2 kitchen timers (to be set at 20 minutes) - these run down to zero at which point a 'beeper' is activated, 2 task methods 'A' and 'B' that allows for dual testing (if required) together with researcher's marking sheets and the operating instructions. The task requires a participant to remember to carry out three time-based tasks and the three event-based tasks. The time-based tasks require the participant to remember to complete each task at appropriate times during the test (e.g. return a set of keys to the researcher when there are seven minutes remaining on the clock). In the case of the event-based tasks the participant is required to remember to complete a task when an appropriate

cue is given (i.e. when a particular word is read on a question sheet) they have to return a book to the researcher. Most of the time during the test, the participants are busy completing a book of puzzles that are used as a distracting element in the task. In addition, when the clock has gone down from 20 minutes to 13 minutes the participant is introduced to a general knowledge quiz and it is when the particular word is reached among the many questions listed, that the book is returned.

The instructions for the CAMPROMPT task were read to the participant at the appropriate time during the task. The task comprises a number of components. Firstly, each participant was asked to remember five objects that were placed in front of them on the desk:- a blue highlighter pen, a Hong Kong stamp, two coloured paperclips, a Spiderman tag, and finally a white plastic medicine spoon. The researcher named each item and then informed the participant that he would hide each item in a different location in the room and that the participant needed to identify each item and where it was hidden at the end of the test (event-based task 1). Secondly, the participant was told that when 7 minutes (time-based task 1) were left on the timer (following activation) that he/she should return a set of keys that were placed on the desk and in full view. Thirdly, they were informed that at some time, when doing the puzzles (although they had not yet started), the researcher would interrupt them to ask them to complete a general knowledge quiz and that when a question arose about EastEnders (event-based task 2) then he/she should return a book that was handed over to them at this point. The puzzle book was then handed over (which comprised of simple puzzles that were filler items and not measured) and then the two kitchen timers were started simultaneously.

Whilst doing the puzzles and at 18 minutes to go (from the 20 minutes) the participant was interrupted by the researcher who asked them to read a card that informed them that when 5 minutes left (event-based task 3) was announced by the researcher they had to return to the researcher an envelope that had the word 'message' written upon it. At 16 minutes, the participant was interrupted again and asked to remember that when 7 further minutes had passed (time-based task 2) they were to change to using a red pen from a black one. Then at 15 minutes (time-based task 3) the participant was again interrupted from the work on the puzzles, to be asked to remind the researcher that he had to ring the garage regarding his car at a particular time that was calculated as being five minutes after the completion of the whole of the CAMPROMPT test. Following this, at 13 minutes, the participant was interrupted yet again and asked to complete the general knowledge quiz sheet (the quiz with the question about East Enders). The researcher then observed whether he/she had remembered the tasks at the times/ events requested.

The scoring scheme for CAMPROMPT covers the three TIME-based elements and the three EVENTS-based elements. There are three levels of scoring; a) where the examinee spontaneously carries out the task and gets it correct they are awarded a maximum of 6 points, where the examinee carries out the wrong task and then are prompted and then gets task right they are awarded 4 points, where the examinee carries out the wrong task and then are prompted yet again and still carries out the wrong task and needs further prompting, they are awarded 2 points. Where there is no response from the examinee at the appropriate time or event and is then prompted and gets task correct they are awarded 4 points, where there is no response, are

prompted more than once and gets task right they are given 2 points, where there is no response and they are prompted more than once and still gets it wrong they are awarded 1 point. Where the examinee is repeatedly prompted and there is no response or continually gets it wrong they are given no points.

The Prospective and Retrospective Memory Questionnaire (PRMQ)

This is a single sheet self-report test developed by Crawford et al., (2003) which measures PM and retrospective memory (RM). The scale shows high internal consistency, the reliabilities of the Total Scale and the Prospective and Retrospective scales were Cronbach's alpha 0.89, 0.84, and 0.80 respectively (Crawford et al. 2003). It contains 16 questions which the participant is asked to complete by circling one of the five possible answers shown immediately below the question (e.g. (Question) "Do you remember to do something then after a few minutes forget to do it?" (Answer) Very Often (score awarded = 5), Quite Often (score = 4), Sometimes (score = 3), Rarely (score = 2), Never (score = 1). Following completion these 16 questions are divided into the four subscales mentioned above (i.e. prospective memory long-term (PMLT), prospective memory short-term (PMST), retrospective memory long-term (RMLT) and retrospective memory short-term (RMST)). The scores are totalled for each sub-scale, with the higher the score indicating more lapses in everyday PM and RM.

The Recreational Drug Behaviour Questionnaire (RDBQ)

The RDBQ is a self-report measure of recreational drug use, including smoking, alcohol and other substance use. This is the same questionnaire as used in Study 1.

The Hospital Anxiety and Depression Scale (HADS)

This is a self-report questionnaire containing 14 questions, 7 of which were designed to measure levels of anxiety and 7 questions designed to measure depression (Snaith and Zigmund, 1994). The focus is on the person's mood over the last few days. Each question was allotted four answers with each answer being given a score. An example of an anxiety question would be - Question. "I feel tense or wound up" - with possible answers such as a) Most of the time (score = 3), b) A lot of the time (score = 2), c) Occasionally (score = 1), d) Not at all (score = 0). An example from the depression scale would also be scored 0 - 3. An illustration of a depression question would be "I still enjoy things as I used to enjoy". The answers could be one of the following: Hardly at all - with a score of 3, Only a little - scoring 2, Not quite as much -scored at 1 and Definitely as much - that scored zero. The higher the score on this measure indicates more anxiety or depression.

The PMQ Strategy scale

This was the 14 item strategy scale taken from the PMQ used in Study 1.

Procedure

Ethical approval for the study was provided by the Staff Ethics Committee of the School of Psychology and Sport Sciences at Northumbria University indicating that the approval adhered to the British Psychological Society's ethical guidelines. Each participant was informed of their right to withdraw from the study at any time or have their data destroyed later, if they so wished. They were given an ID code for this purpose (which was identified on testing pack, Consent and Debrief forms).

Each participant completed the Consent Form that asked for their name, signature, date, telephone number/e-mail address and to tick one of three boxes indicating whether or not they smoked or had smoked in the past and included an ID code. Each participant was asked to complete the NART used as a measure of pre-morbid IQ, followed by the CAMPROMPT as an objective measure of PM. Then each participant was presented with a response pack, containing the Prospective and Retrospective Memory Questionnaire (PRMQ) as a self-report measure of PM, followed by the Recreational Drug Behaviour Questionnaire (RDBQ), the mood questionnaire in the form of the Hospital Anxiety and Depression scale, and finally the strategy scale taken from the PMQ.

Following completion of these tasks each participant was provided with a copy of the debriefing sheet that thanked them for their participation and gave further details of the study. They were reminded of their right to have their data withdrawn from the study at any time by giving their unique ID code (contained on the debriefing sheet). Participants were advised that feedback, in the form of overall findings, could be sought by contacting the researcher or Supervisor after the end of July, 2007. The whole testing time took approximately 40 minutes per participant and the participants were tested on an individual basis and in a quiet laboratory setting.

3.3 Results

The results were collated and computed using SPSS version 12. The data was analysed across the smokers, non-smokers and previous smokers. Table 3.1 below represents the means and standard deviations for the non-memory measures of other drug use and Table 3.2 represents the means and standard deviations for the other non-memory measures, across the three groups.

Table 3.1 Means and Standard Deviations for non-memory measures of the weekly units of alcohol, weekly joints of cannabis, weekly use of ecstasy tablets as reported by smokers, non-smokers and previous smokers.

		units of alcohol/week	Cannabis joints/week	Ecstasy tablets/week
Smoker	Mean	25.18	1.64	0.61
N=31	Std. Dev	23.61	2.31	1.26
Non-smoker	Mean	14.55	1.42	0.26
N=31	Std. Dev	11.8	5.05	1.12
Previous	Mean	16.06	0.56	0
N=31	Std. Dev	8.64	0.89	0

Table 3.2 Means and Standard Deviations for non-memory measures: age, measures of NART converted scores (I.Q), levels of Anxiety and Depression (HADS), as well as the number of strategies used as reported by smokers, non-smokers and previous smokers.

		age	NART	Anxiety	Depression	strategies
Smoker	Mean	24.42	116	7.87	3.61	4.08
N=31	Std. Dev	5.04	3.45	4.06	2.39	1.46
non-smoker	Mean	22.32	114	7.94	2.81	4.56
N=31	Std. Dev	4.16	3.55	4.08	1.87	1.58
Previous smoker	Mean	26.69	118	8.44	2.75	4.22
N=16	Std. Dev	5.68	3.79	4.3	1.81	1.6

Table 3.3 below presents the relationship between age, gender, units of alcohol use per week, cannabis use per week, ecstasy use per week, other drug use, strategy scores, scores on the NART, scores for anxiety and depression, in relation to the

main dependent measures (i.e. scores on the PMLT, PMST, RMLT, RMST taken from the PRMQ, and scores on the CAMPROMPT). Again it was decided to adopt an ultra-conservative approach to control for any variations across the 3 conditions (smokers, non-smokers and previous smokers) on the covariates, which meant that all of the covariates were incorporated into the ANCOVAs, regardless of whether they were significantly related to the dependent measures or not.

Table 3.3 Shows the p values for the relationship between those covariates displaying significant values and each of the dependent PM measures controlled for in the main series of ANCOVAs that follow.

	Age	Gender	Units of alcohol	Cannabis per week	Ecstasy per week	Other drugs	Strategy score	NART score	Anxiety score	Depression score
PMLT	NS	NS	NS	NS	P<.05	NS	NS	NS	NS	NS
PMST	NS	NS	NS	NS	NS	NS	NS	NS	P<.05	NS
RMLT	NS	NS	NS	NS	NS	NS	NS	NS	P<.05	NS
RMST	NS	NS	NS	NS	NS	NS	NS	NS	P<.05	NS
Time-based CAMPROMPT	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Event-based CAMPROMPT	P<.05	NS	NS	NS	NS	NS	NS	NS	NS	NS
Total CAMPROMPT	P<.05	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3.4 below represents the means and standard deviations for the PMLT, PMST, RMLT and RMST scores taken from the PRMQ, across the three groups.

Table 3.4 Means and Standard Deviations for memory measures: PMLT, PMST, RMLT and RMST form the PRMQ, as reported by smokers, non-smokers and previous smokers.

		PMLT	PMST	RMLT	RMST
Smoker	Mean	10.97	11.42	9.74	9.61
N=31	Std. Dev	2.26	2.38	2.45	2.42
Non-smoker	Mean	10.23	10.39	9.06	9.26
N=31	Std. Dev	2.36	2.32	2.10	2.16
Previous smokers	Mean	10.75	11.81	10.13	9.00
N=16	Std. Dev	1.84	3.08	2.60	2.37

Figure 3.1 below shows the means and standard deviations for the for the total memory scores from the CAMPROMPT, for the smokers, non-smokers and previous smokers.
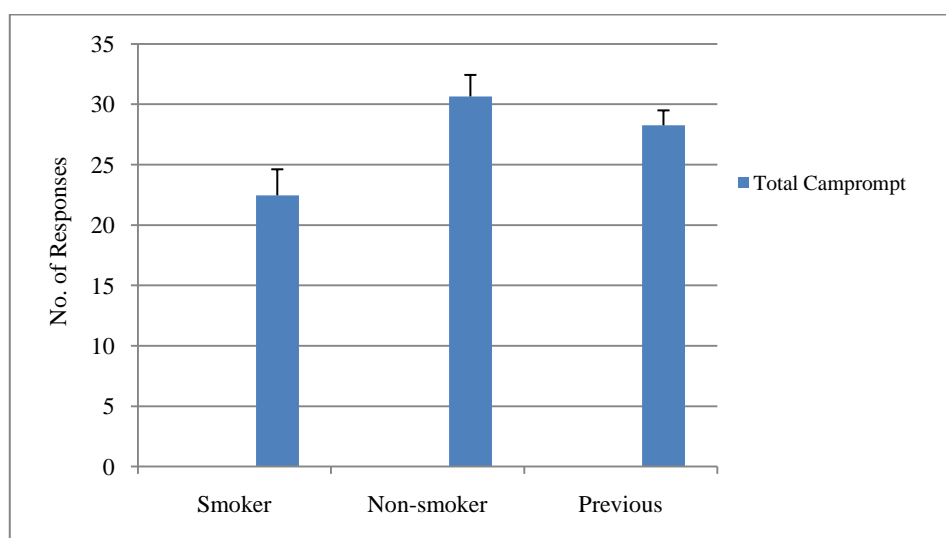
Figure 3.1 Means and Standard Deviations for the Total responses used in comparing smokers, non-smokers and previous smokers.

A series of One-Way Analysis of Co-Variances (ANCOVAs: incorporating age, gender, alcohol use, cannabis use, ecstasy use, other drug use (Yes/No), anxiety, depression, strategy use and IQ covariates) and Pairwise Comparisons (with Bonferroni corrections where appropriate) were applied to the data for smoking condition (non-smokers, smokers and previous smokers) on each of the memory measures (i.e. PMLT, PMST, RMLT, RMST and CAMPROMPT scores). These revealed the following.

For the PRMQ data, there were no significant main effect of smoking condition on PMLT [$F(2, 65) = 0.64$, $p=.53$], PMST [$F(2, 65) = 0.82$, $p=.44$], RMLT [$F(2, 65) = 1.40$, $p=.25$], and RMST scores [$F(2, 65) = 0.17$, $p=.84$].

For CAMPROMPT total there was a significant main effect of smoking condition [$F(2,65) = 45.6$, $p<.001$]. Pairwise comparisons revealed that the non-smokers (Mean = 30.6) performed better than smokers (Mean = 22.45) ($p<.001$), the previous smokers (Mean = 28.2) performed better than the smokers (Mean = 22.4) ($p<.001$), with no difference between non-smokers and previous smokers. From the CAMPROMPT totals it is clear that previous smokers and non-smokers perform significantly better than smokers, with no difference in performance between the previous and non-smoker groups.

For CAMPROMPT time-based tasks there was a significant main effect of smoking condition [$F(2,65) = 19.8$, $p<.001$]. Pairwise comparisons revealed that the non-smokers (Mean = 15.5) performed better than smokers (Mean = 11.0) ($p<.001$)

and the previous smokers (Mean = 13.3) (p<.001), previous smokers performed better than the smokers (p<.01). From the CAMPROMPT time-based data it is clear that previous smokers and non-smokers perform significantly better than smokers, with non-smokers performing better than previous smokers, it appears that previous smokers fall between the other two groups.

For CAMPROMPT event-based tasks there was a significant main effect of smoking condition [F(2,65) = 24.8 p<.001]. Pairwise comparisons revealed that the non-smokers (Mean = 15.0) performed better than smokers (Mean = 11.4) (p<.01), the previous smokers (Mean = 14.8) performed better than the smokers (p<.01), with no difference between non-smokers and previous smokers. From the CAMPROMPT event-based data it is clear that previous smokers and non-smokers perform significantly better than smokers, with no difference in performance between the previous and non-smoker groups.

Correlational Analyses.

In addition to the main analyses three sets of correlations were carried out: one that assessed the association between the number of cigarettes smoked and the self-reported and objective measures of PM, a second set that assessed the association between how long the person had smoked and the self-reported and objective measures of PM, and a third set that assessed the association between the lifetime usage of cigarettes and the self-reported and objective measures of PM across all current smokers from the study. The purpose of these correlational analyses was to observe whether the number of cigarettes smoked, how long the person had been

smoking and lifetime cigarette use in the current smokers was associated with a particular pattern of memory lapses on the PMLT, STPM, RMLT, and RMST (sub-scales of the PRMQ) and recall on the CAMPROMPT.

A set of Pearson Product Moment correlations was applied to the data to assess the association between the number of cigarettes smoked and the self-reported and objective measures of PM. This revealed no significant correlation between the number of cigarettes smoked and PMLT scores ($r(31)=-0.04$, $p=.82$), no significant correlation between the number of cigarettes smoked and PMST scores ($r(31)=-0.17$, $p=.35$), no significant correlation between the number of cigarettes smoked and RMLT scores ($r(31)=0.09$, $p=.59$), no significant correlation between the number of cigarettes smoked and RMST scores ($r(31)=-0.13$, $p=.45$), and finally, no significant correlation between the number of cigarettes smoked and total CAMPROMPT scores ($r(31)=-0.32$, $p=.07$).

A set of Pearson Product Moment correlations was applied to the data to assess the association between how long the person had smoked and the self-reported and objective measures of PM. This revealed no significant correlation between length of smoking and PMLT scores ($r(31)=-0.05$, $p=.76$), no significant correlation between length of smoking and PMST scores ($r(31)=0.14$, $p=.43$), no significant correlation between length of smoking and RMLT scores ($r(31)=0.06$, $p=.73$), no significant correlation between length of smoking and RMST scores ($r(31)=.14$, $p=.45$), but there was a significant negative correlation between length of smoking and total CAMPROMPT scores ($r(31)=-0.46$, $p<.01$) indicating that the longer one has

smoked the worse their performance on the CAMPROMPT, which is depicted in

Figure 3.2.
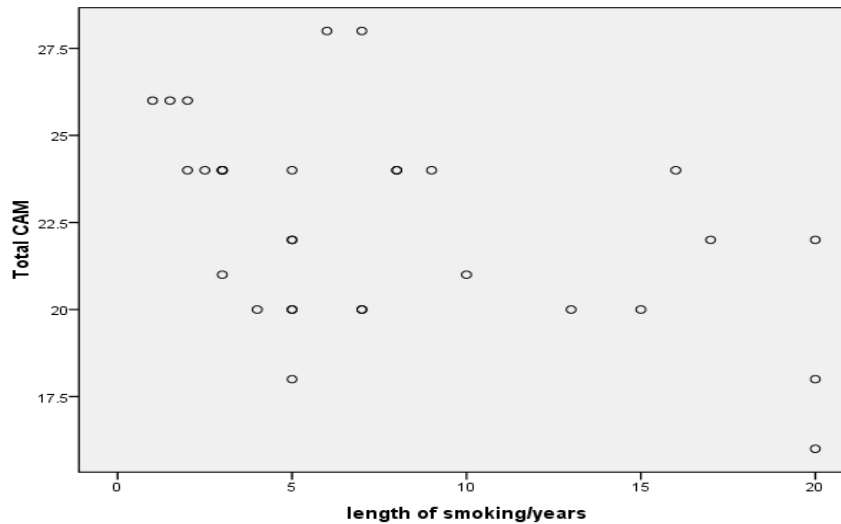
Figure 3.2 A significant negative correlation between the length of time the person had smoked and scores on the CAMPROMPT, indicating that the longer one had smoked the poorer their performance was on the CAMPROMPT.

A set of Pearson Product Moment correlations was applied to the data to assess the association between the lifetime usage of cigarettes and the self-reported and objective measures of PM. This revealed no significant correlation between lifetime usage and PMLT scores ($r(31)=-0.06$, $p=.73$), no significant correlation between lifetime usage and PMST scores ($r(31)=0.05$, $p=.77$), no significant correlation between lifetime usage and RMLT scores ($r(31)=0.14$, $p=.44$), no significant correlation between lifetime usage and RMST scores ($r(31)=.06$, $p=.73$). However, there was a significant negative correlation between lifetime usage and total CAMPROMPT scores ($r(31)=-0.51$, $p<.01$) indicating that the greater the lifetime usage the worse their performance on the CAMPROMPT (see Figure 3.3). A partial correlation revealed that when the number of cigarettes were controlled for the

correlation between lifetime usage and scores on the CAMPROMPT remained significant (r(28)=-0.42, p<.05) whereas when the length of smoking was controlled for the correlation between lifetime usage and scores on the CAMPROMPT became non-significant (r(28)=-0.29 p=.12). These results suggest that it is the length of time smoked that is responsible for the correlation between lifetime usage and CAMPROMPT scores, rather than the number of cigarettes smoked per week.

A correlation between lifetime usage and scores on the event-based sub-scale of CAMPROMPT revealed a significant negative correlation (r(31)=-.46, p<.01) – indicating that the greater the lifetime usage the fewer items were recalled on the CAMPROMPT (see Figure 3.4). A partial correlation revealed that when the number of cigarettes were controlled for the correlation between lifetime usage and scores on the event-based CAMPROMPT was no longer significant (r(28)=-0.29, p=.11) and that when the length of smoking was controlled for the correlation was again non-significant (r(28)=-0.12 p=.50). The partial correlations indicate that the significant relationship between lifetime cigarette use and event-based CAMPROMPT scores is explicable in terms of both the length of smoking and the number of cigarettes smoked per week contributing to this correlation. The correlation between lifetime usage and scores on the time based sub-scale of CAMPROMPT was non-significant (r(31)=-.35, p=.051).

The finding that scores on the total CAMPROMPT was related to the length of smoking and lifetime usage suggests that the longer one had smoked the poorer their PM on the objective measure.

Figure 3.3   A significant negative correlation between lifetime usage of cigarettes and scores on
the CAMPROMPT total, indicating that the greater the lifetime usage the worse
their performance on the CAMPROMPT (i.e. the worse their PM).

Figure 3.4   A significant negative correlation between lifetime usage of cigarettes and scores on
the event-based CAMPROMPT sub-scale, indicating that the greater the lifetime usage the
worse their performance on event-based CAMPROMPT (i.e. the worse their PM).
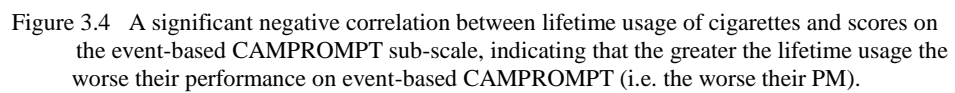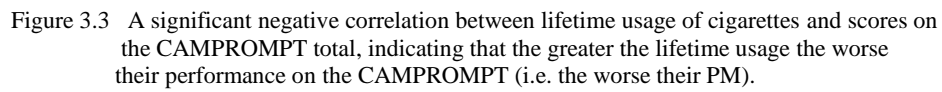
3.4 Discussion

The findings from this study revealed no significant differences between smokers, non-smokers and previous smokers on any of the subscales of the self-report PM measure. This was not consistent with the findings from Study 1 and also failed to provide support for the long-term PM self-reported deficits found by Heffernan et al., (2005). Mood and IQ were controlled for in the present study which may partially account for the lack of self-reported memory deficits between the groups. It is therefore possible that the self-reported findings (from the PMQ) in the previous study were confounded by variations in mood, given that mood has been shown to affect memory (see e.g. Eich, 1995) and interact with drug use (see e.g. Parrott et al., 2004). It would also be prudent to control for variations in IQ.

The results produced significant differences between the three groups on the objective measure of PM, which was the CAMPROMPT. Specifically it was found that non-smokers outperformed smokers on all three elements of the CAMPROMPT (time-based, event-based and total scores). Previous smokers also outperformed smokers on all three aspects of the CAMPROMPT score and this therefore suggests that cessation from smoking results in some recovery of function in PM. Non-smokers and previous smokers also showed no significant difference in their performance on two of the three CAMPROMPT scores (including the total) suggesting a move towards non-smoking levels of performance, thus bolstering the argument for *some* recovery of function in those who have stopped smoking.

The findings from the objective PM task used in the present study (the CAMPROMPT) was consistent with those from the objective measure used in Study 1 (the PRVP) and consequently together provide convergent evidence to support the concept that persistent smoking may damage everyday PM. Study 1 indicated that some recovery had been achieved by previous smokers in terms of their PRVP performance, where their results were exactly centred between the non-smokers and the smoking group. In the present study the previous smokers showed an even greater recovery of PM function (on the overall CAMPROMPT scores), in that the previous smokers and the non smokers were not significantly different, suggesting a greater recovery of PM function that found in Study 1. Although Studies 1 and 2 have suggested that smoking leads to PM impairments, again one must be cautious with one's interpretation. For example, it must be realised that findings from the self-reports produced mixed findings across both studies. Secondly, no firm conclusion should be reached based on two findings from objective measures alone (that of the PRVP in Study 1 and the CAMPROMPT result in the present study).

Study 2 used CAMPROMPT that gave the opportunity to extend the measure of PM to include an extra component (i.e. as well as an event-based element as used in the PRVP in Study 1) there was also a time-based element. Both components incorporated in the CAMPROMPT are regularly found within the daily lives of people, for example, having to remember to carry out some task when a cue appears in the environment, as well as having to remember to carry out tasks at particular times during the procedure. Thus, although laboratory-based, CAMPROMPT contains features similar to the real world and can be seen as being highly productive

in teasing out variations between smokers, non-smokers and previous smokers on these components.

Once again the two theories postulated in Study 1 can be used here to offer putative explanations of the poorer CAMPROMPT performance in smokers when compared to non-smokers. CAMPROMPT required the participant to memorise a series of items to be recalled at the end of the study, remember a series of ongoing event-based and time-based actions during a filler task that involved them completing a series of puzzles, as well as remembering to contact the researcher within 24 hours after the task was completed. This would mean that the CAMPROMPT represents a highly demanding task and that, according to the task demands theory postulated in Study 1, smokers would show greater decrements on this task than non-smokers, with previous smokers again showing some recovery in PM function – as explained in the previous study. Within the Multi-Process Model of PM (McDaniel & Einstein, 2007) the findings from the CAMPROMPT are also explicable in terms of the PM task requiring greater effortful processing that might have a more adverse effect on smokers when compared with non-smokers and previous smokers, leading to reduced PM recall in smokers. However, one would not expect the same task demand hypothesis to apply to the self-reported PM data, given the argument postulated in the discussion section in Study 1. Again it is feasible that increased levels of CO in smokers has led to deprivation of oxygen to the brain, resulting in poorer PM performance and that previous smokers show a gradual return to normal oxygen levels and therefore some PM recovery. Any one of these two theories could be used as a theoretical framework to explain the current findings

The results from the correlational analyses applied to the smokers produced mixed findings. There was no relationship between the number of cigarettes used per week and any of the PM measures. Secondly, the length of smoking in years was negatively correlated with CAMPROMPT scores, suggesting that longer one had smoked the fewer the number of items recalled on the CAMPROMPT. However, there were no correlations between length of smoking and scores on any of the sub-scales for the PRMQ. In addition, lifetime usage was negatively correlated with scores on the CAMPROMPT, suggesting that the greater the lifetime usage the fewer the number of items recalled on the CAMPROMPT, with no correlations between lifetime usage and scores on any of the sub-scales for the PRMQ.

The findings from the subscales of the PRMQ are inconsistent with the notion that smoking has a detrimental effect on one's memory. The fact that lower scores on the CAMPROMPT was related to the length of smoking and lifetime usage, suggests that the longer one smokes the poorer ones PM. The finding that the number of cigarettes did not correlate with any of the PM measures does not support the notion that there may be dose-related deficits associated with prolonged smoking. Again, it should be noted that correlations between factors does not imply a causal relationship and does not allow one to judge whether any particular method (e.g. the utilisation of the PRMQ or CAMPROMPT in the present study) is preferable to another method of measuring PM. The implications of these findings are considered in more depth in the General Discussion section.

The most important factor about peoples' use of everyday PM is its actual use in the real world. Their reliance on PM can be seen in real world scenarios they use for everyday living needs. Remembering to meet a friend on a particular day and at a particular time, remembering a wife's birthday and buying the present they said they would like to receive, are highly important personal features of life. It has been noted that laboratory-based research on PM is a useful way of testing theoretical concepts of prospective remembering. But the views that smoking may have an adverse impact upon everyday PM may better be tested outside of the laboratory-based settings and replicated in a real-world or naturalistic environment (McDaniel & Einstein, 2007). If smokers do experience problems with their everyday PM this should be reflected in their real-world setting and it is here that deficits in PM will have most significant impact upon their daily lives. Therefore, it is intended that this task be adopted in Study 3 and so be a more naturalistic and real-world measure of PM. It is to be in the form of a Real World Prospective Memory Task (RWPMT).

3.5 Chapter Summary

Study 2 had four aims. Firstly, to assess self-reported PM lapses in non-smokers, current smokers and previous smokers utilising a more recently validated self-report questionnaire in the form of the PRMQ. Secondly, to observe whether the findings from the objective PM task used in Study 1 would be repeated employing a different objective measure in the form of the CAMPROMPT. The third aim was to observe whether cessation from smoking leads to recovery in PM. Fourthly, the design of the study was made more rigorous by incorporating further covariates in order to control for any between-group differences in mood and IQ. Age, gender, mood, pre-morbid IQ, strategy use and other substances used were also measured and controlled for in the analysis. Once again the results revealed no significant differences between smokers, non-smokers and previous smokers on any of the subscales of the self-report PRMQ. The results revealed that non-smokers and previous smokers outperformed current smokers on overall performance on the CAMPROMPT, with no difference between the non-smokers and previous smokers. In addition, it was shown that the longer current smokers had smoked and the greater their lifetime usage of cigarettes the worse their performance was on the CAMPROMPT. These findings provide additional evidence that prolonged current smoking is associated with lower PM performance and that abstinence from smoking results in some recovery of PM functioning. However there is a need for caution, in that one should not base a clear conclusion on 2 findings alone (i.e. the findings from the PRVP in Study 1 and the CAMPROMPT in the present study).

Chapter 4

Study 3: Comparing smokers, non-smokers and previous smokers on self-reports of PM and the RWPMT.

4.1 Introduction

A number of conclusions were drawn from Study 2. Firstly, no significant differences were found between non-smokers, smokers and the former smokers on any of the sub-scales of the self-report PRMQ. These findings were not consistent with the findings from Study 1 and failed to provide support for the long-term PM self-reported deficits found by Heffernan et al., 2005. Again it is argued here that self-reported PM lapses may be lost once one has controlled for a range of other factors, such as mood, and that such PM measures are perhaps not as reliable as previously thought. However, on the Cambridge Prospective Memory Test (CAMPROMPT), which was used as an objective measure of PM in Study 2, it was found that non-smokers recalled significantly more items than smokers, with no significant differences between non-smokers and the previous group. It was also revealed that the more cigarettes smoked throughout the smoker's lifetime the worse the performance was on the CAMPROMPT. The finding that smokers performed significantly worse on the CAMPROMPT was consistent with the findings on the PRVP from Study 1.

The findings from Study 1 (using the PRVP) and Study 2 (using the CAMPROMPT) provide convergent evidence that persistent smoking is associated with lower PM functioning. The findings also suggested that cessation from smoking

for more than six months leads a recovery in function in PM to levels observed in non-smokers. However, as noted previously, the mixed findings derived from the self-reports of PM used in Study 1 (using the PMQ) and Study 2 (using the PRMQ), as well as the fact that only 2 measures of PM have shown deficits in smokers, suggest a need for cautious interpretation.

Although both Studies 1 and 2 produced converging evidence of objective PM deficits associated with prolonged smoking, both used a laboratory-based setting. As noted by previous authors in the field, it is important to test hypotheses developed in laboratory-based settings in a real world context (McDaniel & Einstein, 2007). Since PM is critical for independent living, any problems experienced by smokers may have the greatest impact upon their everyday functioning. It was therefore seen as important to assess PM within a more natural, real world setting. Study 3 aimed to achieve this by examining whether such deficits in PM extend to a Real-World PM task (RWPMT). Although the PRMQ did not provide any consistent smoking-related lapses in PM (as discussed earlier) it would be unwise to base any final conclusion about the use of the PRMQ on one study alone. Therefore it was decided to use the PRMQ once more to observe whether any consistent pattern emerges. The PRMQ was once again used in order to conclude whether or not self-reported PM deficits were associated with continued smoking. In addition, age, gender, other drug use, mood, strategy use and IQ were measured and controlled for in the study.

Based on the findings from the PRVP in Study 1 and the results from the CAMPROMPT in Study 2 it is predicted here that smokers will perform worse on

the Real World Prospective Memory Task (RWPMT) than non-smokers. Also, based on the fact that previous group either fell between the other two groups (Study 1) or performed at non-smoking levels (Study 2) in their performance on the objective measures from Studies 1 and 2, no firm prediction was made with regards this group. Given the inconsistent findings from the self-reported PM from Studies 1 and 2, no predictions were made with regards the PRMQ.

Rationale for Methodology Adopted.

Study 3 adopted a Real World Prospective Memory Task (RWPMT) which required each participant to remember 15 actions at 15 different locations whilst being taken on a tour of the University Campus by the researcher, as an objective measure of PM. This task was developed in response to current research thinking in which it was suggested that more naturalistic studies of PM are needed within the field of PM (McDaniel & Einstein, 2007). The use of the RWPMT was seen as more ecologically valid than the methods used in the two previous laboratory-based studies and allows one to focus on whether there are PM deficits associated with prolonged smoking within a real world paradigm. The inclusion of the RWPMT was a further attempt to provide convergent evidence in relation to whether persistent smoking leads to impairments in PM. The Prospective and Retrospective Memory Questionnaire (PRMQ: Crawford et al., 2003) was maintained as a self-report measure in order to attempt to verify whether there were any consistent self-reported deficits in smokers, non-smokers or previous smokers. Given that the PRMQ had only been used once thus far, it was decided to utilise it again here before reaching any firm conclusions about self-report PM associated with smoking. Covariates in

the form age, gender, strategy use, other drug use (including alcohol, cannabis and ecstasy), mood and IQ were again measured (based on the same rationale as considered in Study 2) and included in the analysis.

4.2 Method

Pilot Study

The pilot study was conducted to test whether floor or ceiling effects were evident and whether the procedure was easily understood. Eight females and two males were tested, with a mean age of 29.4 years, comprising 2 smokers, 1 previous smoker and 7 non-smokers. The participants were an opportunity sample selected from students studying at a North-Eastern University. The RWPMT consisted of each participant being provided with a list of 15 location-action combinations for a two minute rehearsal period before they were taken on an actual tour around the university campus with the specific instructions that they should remember each location-action combination (see Appendix 4 for full set of the location-action/memory combinations). During the tour their task was to tell the researcher when a particular location was reached (by the participant stopping and identifying the location) and what the associated action/memory was, (e.g. when they reached the Student Union they identified this location and told the researcher when the next gig was). One point was given for each location-action/memory combination successfully recalled because for one to be successful at a PM task it is necessary to remember both the location as well as the appropriate action for that location, with a maximum of 15 points achievable. The results of the pilot study revealed an average score of 10.3 location-action/memory combinations [Range from 6 − 15, with only

one person achieving the maximum score of 15 (SD=2.49)]. It was therefore concluded that no systematic floor or ceiling effects were evident in the procedure. Qualitative feedback revealed no operational difficulties in the instructions provided or in the procedure. Therefore, the materials and procedure remained the same for the main study.

Design

The present study employed a non-experimental, existing-groups design. There was one independent factor which had 3 levels: smokers, non-smokers and previous (previous) smokers. Five dependent measures were assessed. The self-reported PM scores achieved on the Prospective and Retrospective Memory Questionnaire (PRMQ: Crawford, et al., 2003) with subscales for (1) PM long-term (PMLT), (2) PM short-term (PMST), (3) retrospective memory long-term (RMLT) and (4) retrospective memory short-term (RMST). Note: RM sub-scales from the PRMQ were included here since it is part of the PRMQ and may provide some insights into this aspect of everyday remembering. Finally the scores on the Real-World Prospective Memory Task (RWPMT) (5).

There were ten covariates measured: age (1), gender (2), Drug use characteristics comprising alcohol use in weekly units (3), cannabis use in joints per week (4), and ecstasy (MDMA) use in terms of the number of tablets per week (5) and other drug usage (6). In addition mood was measured in the form of the HADS anxiety (7) and depression (8), the scores on the strategy scale taken from the PMQ (9) and a pre-morbid measure of IQ in the form of the NART scores (10). Once again cigarette

characteristics (e.g. the number of cigarettes smoked per week) were used only to distinguish the 3 groups and not used as covariates in the main analysis.

Covariation was to be used to control for any differences between the smokers, previous smokers and non-smokers on the non-memory measures. As an additional control measure it was decided that the order in which the tests were administered would remain constant across all the participants tested. The first test to be used was the NART, followed by the drug questionnaire, then, the Hospital Anxiety and Depression Scale (HADS) questionnaire, then followed the PRMQ tests, and finally, the strategy questionnaire.

Participants

A total of 69 people took part in the study. There were 27 smokers, with a mean age of 22.4 years (SD=5.13, with 11 males and 16 females), who smoked on average 60.7 cigarettes per week (SD=33), with a range of between 20 and 140 cigarettes per week (with the most frequently occurring number being 40 cigarettes per week) and had smoked for an average of 6.24 years (SD=4.73). The smokers had last had a cigarette on average 3.24 hours prior to testing (SD=7.38). There were 24 non-smokers with a mean age of 19 years (SD=2.22, with 3 males and 21 females). There were 18 previous smokers with a mean age of 23.7 years (SD=5.99, with 3 males and 15 females) and had been stopped smoking for an average of 2.36 years (SD=2.76). All participants were recruited using an opportunity sampling method and were all university undergraduates studying in the North East of England. Some of the

participants were paid volunteers, whilst others received points as a reward via a University system.

Materials

The National Adult Reading Test (NART)

The NART provides a measure of pre-morbid IQ (NART: Nelson and Willison, 1991) and was the same measure and administration procedure as used in Study 2.

The Recreational Drug Behaviour Questionnaire (RDBQ)

The RDBQ is a self-report measure of recreational drug use, including smoking, alcohol and other substance use. This is the same questionnaire as used in previous studies.

The Hospital Anxiety and Depression Scale (HADS)

This is a self-report questionnaire designed to measure levels of anxiety and depression (Snaith and Zigmund, 1994). This is the same questionnaire as that used in Study 2.

The Prospective and Retrospective Memory Questionnaire (PRMQ)

This is a single sheet self-report test developed by Crawford et al., (2003) which measures PM and retrospective memory (RM). This is the same questionnaire as that used in Study 2.

The PMQ Strategy scale

This was the 14 item strategy scale taken from the PMQ used in previous studies.

Real World Prospective Memory Task (RWPMT)

The RWPMT consisted of 15 Location – Action combinations which comprised of 15 locations around a university campus, each of which had an associated action. A list of these 15 combinations was presented to each participant for them to study for a two minute period. It was also made clear that each of the fifteen items contained two parts – one being a LOCATION (a place) on the University campus, the other an ACTION to be remembered with the location. Example items included (e.g. "At the Students Union" and "When is the next Gig"; "At Rutherford Hall" and "Where is the nearest telephone?"). The order in which these combinations appeared on the list read by the person was different from the order in which they appeared on the actual tour of the campus, in order to reduce any strategy being used before the tour began. Following the two minute period, the researcher and participant toured the University campus where the participant was expected to recall both the location and the associated action as they reached each location. If a correct answer for the combination of location and action was provided, a tick was place on the researcher's record sheet. At the end of the tour the number of correct answers was totalled and a score decided upon by the researcher.

An additional item was added (which was not included in the pilot study) by which the person was asked to remember to return a set of coloured paper clips

which was given to them before testing began. The inclusion of the paper clips was an attempt to increase the ecological validity of the task (i.e. the task represented the type of long-term PM remembering that would be done in real life). This final total for the RWPMT was a maximum score of 16 points with the higher the score indicating a better PM. The RWPMT was deemed to have face validity in that its aim was to test a person's ability to remember to do particular activities at particular locations on a tour around the university campus, thus tapping into everyday PM. The use of more naturalistic studies of this type is a welcomed move in terms of current research thinking within the field of PM (McDaniel & Einstein, 2007). In order to demonstrate the RWPMT's validity, concurrent validity between the scores on the RWPMT were correlated with total scores on the PRMQ with the results demonstrating weak concurrent validity of the RWPMT [r(69)=0.01, p=.46]. In order to demonstrate the RWPMT's reliability, a split-half reliability test was conducted on the first half scores (using items 1 – 8) and the second half score (items 9 - 16) on the RWPMT results from the total number of participants from the study. The results of the split-half reliability check showed good reliability [r(69)=0.46, p<.001].

Procedure

Ethical approval for the study was provided by the Staff Ethics Committee of the School of Psychology and Sport Sciences at Northumbria University indicating that the approval adhered to the British Psychological Society's ethical guidelines. Each participant was informed of their right to withdraw from the study at any time or have their data destroyed later, if they so wished. They were given an ID code for this purpose (which was identified on testing pack, Consent and Debrief forms).

Each participant completed the Consent Form that asked for their name, signature, date, telephone number/e-mail address and to tick one of three boxes indicating whether or not they smoked or had smoked in the past and included an ID code.

Each participant was asked to complete the NART as a measure of pre-morbid IQ, followed by a response pack, containing the Recreational Drug Behaviour Questionnaire (RDBQ), Hospital Anxiety and Depression scale, Prospective and Retrospective Memory Questionnaire (PRMQ) as a self-report measure of PM, the strategy scale taken from the PMQ, and finally the Real-World Prospective Memory Task (RWPMT). Following completion of these tasks each participant was provided with a copy of a Debriefing sheet that thanked them for participating and provided further details of the study. They were reminded of their right to have their data withdrawn from the study at any time by them providing their unique ID code (contained on the debriefing sheet). Participants were advised that feedback of overall findings could be sought by contacting the researcher or Supervisor after the end of September, 2007. The whole testing time took approximately 50-60 minutes per participant and the participants were tested on an individual basis.

4.3 Results

The results were collated and computed using SPSS version 15. The data was analysed across the three levels of condition as the independent factor: smokers, non-smokers and previous smokers. Table 4.1 below represents the means and standard deviations for the non-memory measures of other drug use and Table 4.2 represents

the means and standard deviations for the other non-memory measures, across the three groups.

Table 4.1 Means and Standard Deviations for non-memory measures of the weekly units of alcohol, weekly use - joints of cannabis and the weekly use of ecstasy tablets as reported by smokers, non-smokers and previous smokers.

		Units of Alcohol/week	No. of Cannabis Joints/week	No. of Ecstasy tablets/week
Smoker N = 27	Mean	31	1.04	0.67
	Std Dev	25.15	1.32	1.14
Non-smoker N = 24	Mean	20.58	0.04	0
	Std Dev	17.56	0.2	0
Previous N = 18	Mean	18.22	1	0.72
	Std Dev	18.36	1.82	1.57

Table 4.2 Means and Standard Deviations for non-memory measures of age, measures of NART converted scores (I.Q), levels of Anxiety, levels of Depression and the number of strategies used as reported by smokers, non-smokers and previous smokers.

		NART	MOOD Anxiety	MOOD Depression	Strategies
Smoker N = 27	Mean	116	6.81	2.59	3.98
	Std Dev	3.17	3.52	1.87	1.45
Non-smoker N = 24	Mean	116	6.17	2.13	4.53
	Std Dev	3.12	3.43	1.62	1.69
Previous N = 18	Mean	117	6.06	2.89	4.47
	Std Dev	2.4	3	3.46	1.2

Table 4.3 below presents the relationship between age, gender, units of alcohol use per week, cannabis use per week, ecstasy use per week, other drug use, strategy scores, scores on the NART, scores for anxiety and depression, in relation to the

main dependent measures (i.e. scores on the PMLT, PMST, RMLT, RMST taken from the PRMQ, and scores on the RWPMT). Again it was decided to adopt an ultra-conservative approach to control for any variations across the 3 conditions (smokers, non-smokers and previous smokers) on the covariates, which meant that all of the covariates were incorporated into the ANCOVAs, regardless of whether they were significantly related to the dependent measures or not

Table 4.3   Shows the p values for the relationship between those covariates displaying significant values and each of the dependent measures controlled for in the following ANCOVAs.

	Age	Gender	Units of alcohol	Cannabis per week	Ecstasy per week	Other drugs	Strategy score	NART score	Anxiety score	Depression score
PMLT	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
PMST	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
RMLT	NS	NS	NS	NS	NS	NS	NS	NS	P<.05	NS
RMST	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Real-World PMT	NS	P<.05	NS	NS	P<.05	P<.05	NS	NS	NS	NS

Table 4.4 represents the means and standard deviations for the PMLT, PMST, RMLT and RMST scores taken from the PRMQ, across the three groups.

127

Table 4.4 Means and Standard Deviations for memory measures: PRMQ memory measures used in the study – PM Long-Term (PMLT), PM Short-term (PMST), Retrospective Memory Long-Term (RMLT), and Retrospective Memory Short-term (RMST), as reported by smokers, non-smokers and previous smokers.

		PMLT	PMST	RMLT	RMST
Smoker	Mean	11.30	12.41	9.7	10.33
N = 27	Std. Dev	2.67	3.04	2.6	2.37
Non-smoker	Mean	9.83	10.92	9.04	9.25
N = 24	Std. Dev	2.93	2.95	2.35	2.42
Previous	Mean	10.89	11.94	9.72	9.78
N = 18	Std. Dev	2.08	2.53	3.1	2.46

Figure 4.1 below contains the means and standard deviations for the Total memory scores from the Real World Prospective Memory Task (RWPMT), for the smokers, non-smokers and previous smokers.
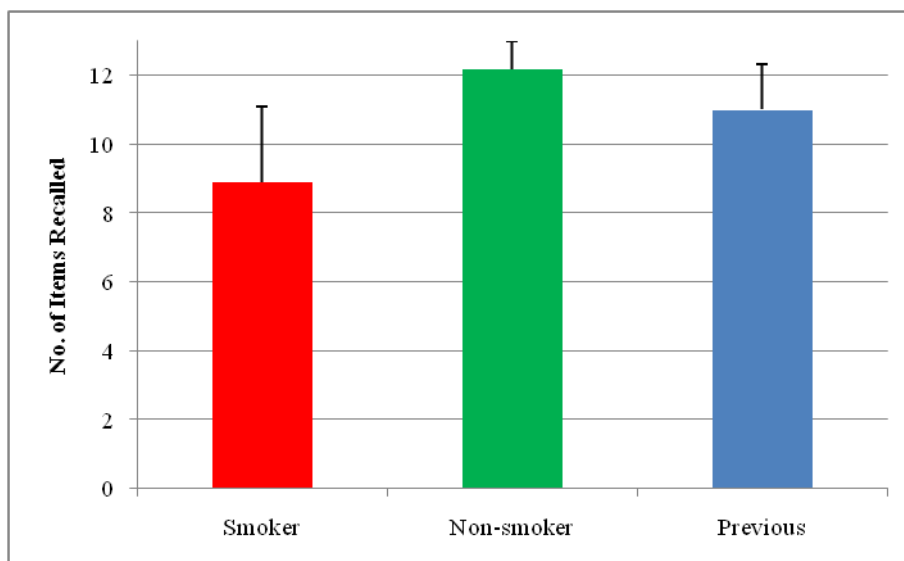
Figure 4.1. Means and Standard Deviations for the correct number of recalled items from the Real World Prospective Memory Task (RWPMT) that compared smokers, non-smokers and previous smokers.

A series of One-Way Analysis of Co-Variances (ANCOVAs: incorporating age, gender, alcohol use, cannabis use, ecstasy use, other drug use (Yes/No), anxiety, depression, strategy use and IQ covariates) and Pairwise Comparisons (with

Bonferroni corrections) – where appropriate - were applied to the data for smoking condition (non-smokers, smokers and previous smokers) on each of the memory measures (i.e. PMLT, PMST, RMLT and RMST scores).

For the PRMQ data, there was no significant main effect of smoking condition on PMLT [F (2, 55) = 1.52, p=.22], nor on the PMST [F (2, 55) = 1.71, p=.91], nor on the RMLT [F (2, 55)=0.48, p=.61], nor for the RMST scores [F (2, 55) = 1.10, p=.33].

For the RWPMT data there was a significant main effect of smoking condition [F (2, 55) = 18.7, p<.001]. For the RWPMT a set of Pairwise Comparisons revealed the following. Non-smokers (Mean = 12.1; SD=0.82) recalled significantly more than smokers (Mean = 8.89; SD=2.21) (p<.01), previous smokers (Mean = 11; SD=1.33) recalled significantly more that smokers (P<.01), with no significant difference between the non-smokers and previous smokers. From the RWPMT data it is clear that previous smokers and non-smokers perform significantly better than smokers, with no difference in performance between the previous and non-smoker groups.

Correlational Analyses.

In addition to the main analyses three sets of correlations were carried out: one that assessed the association between the number of cigarettes smoked and the self-reported and objective measures of PM, a second set that assessed the association between how long the person had smoked and the self-reported and objective

measures of PM, and a third set that assessed the association between the lifetime usage of cigarettes and the self-reported and objective measures of PM across all current smokers from the study. The purpose of these correlational analyses was to observe whether the number of cigarettes smoked, how long the person had been smoking and lifetime cigarette use in the current smokers was associated with a particular pattern of memory lapses on the PMLT, STPM, RMLT, and RMST (sub-scales of the PRMQ) and recall on the RWPMT.

A set of Pearson Product Moment correlations was applied to the data to assess the association between the number of cigarettes smoked and the self-reported and objective measures of PM. This revealed no significant correlation between the number of cigarettes smoked and PMLT scores ($r(27)=0.21$, $p=.27$), no significant correlation between the number of cigarettes smoked and PMST scores ($r(27)=0.11$, $p=.56$), no significant correlation between the number of cigarettes smoked and RMLT scores ($r(27)=-0.05$, $p=.79$), no significant correlation between the number of cigarettes smoked and RMST scores ($r(27)=-0.01$, $p=.94$), and no significant correlation the number of cigarettes smoked and RWPMT scores ($r(27)=-0.02$, $p=.91$).

A set of Pearson Product Moment correlations was applied to the data to assess the association between the length of smoking and the self-reported and objective measures of PM. This revealed no significant correlation between the length of smoking and PMLT scores ($r(27)=0.22$, $p=.26$), no significant correlation between the length of smoking and PMST scores ($r(27)=0.21$, $p=.29$), no significant

correlation between the length of smoking and RMLT scores (r(27)=-0.26, p=.17), no significant correlation between length of smoking and RMST scores (r(27)=0.13, p=.50), and no significant correlation between length of smoking and RWPMT scores (r(27)=0.09, p=.65).

A set of Pearson Product Moment correlations was applied to the data to assess the association between the lifetime usage and the self-reported and objective measures of PM. This revealed no significant correlation between lifetime usage and PMLT scores (r(27)=0.15, p=.43), no significant correlation between lifetime usage and PMST scores (r(27)=0.16, p=.41), no significant correlation between lifetime usage and RMLT scores (r(27)=-0.21, p=.27), no significant correlation between lifetime usage and RMST scores (r(27)=0.03, p=.85), and no significant correlation between lifetime usage and RWPMT scores (r(27)=0.09, p=.64).

4.4 Discussion

The findings from the present study revealed no significant differences between smokers, non-smokers and previous smokers on any of the subscales of the self-report PM measure. The lack of any significant findings from the PRMQ replicates the findings from Study 2. It should be noted that the PMQ was used in Study 1. It is interesting that none of the self-reported data from Studies 1 – 3 supported the long-term PM self-reported deficits found by Heffernan et al., (2005). The lack of consistency across several studies (Heffernan et al., and the 3 studies incorporated into this thesis) using self-reports of PM in relation to smoking may be explicable in terms of the unreliability of self-report questionnaire used to assess PM. This lack of

consistency has also been found with studies into other drug research. For example, Rodgers et al., (2001) found that cannabis users reported more short-term and internally-cued deficits in PM when compared with non-users, whereas in a more recent study Bartholomew et al., (in press) failed to replicate these findings.

It would appear that self-reports of PM should not be relied upon alone to conclude whether deficits are associated with particular substance misuse. The results of Study 3 revealed again that both previous and non-smokers performed significantly better on the RWPMT task than smokers, with the previous group performing at non-smoking levels. It is highly significant that once again the findings between smokers and non-smokers on the RWPMT follows the same pattern as those found in Study 1 on the PRVP and Study 2 on the CAMPROMPT. The findings from the RWPMT reinforce the view that smoking is associated with lower performance in everyday PM, and, reveals that this lower performance within a real-world scenario – a potentially important finding given that no other research to date has considered what impact current smoking has upon everyday memory. Taken as a whole, the findings from the objective measures in all three studies suggest that PM impairments are associated with prolonged smoking. Yet again the superior performance of the previous smoker group when compared with the current smokers supports the notion that there could well be some element of recovery of PM function when smoking is ceased.

As with studies 1 and 2, again the two theories postulated with regards task demands and elevated CO levels associated with smoking can be used here to offer

putative explanations of the poorer RWPMT performance in smokers when compared to non-smokers. The RWPMT was similar to the PRVP in its complexity except that it involved location-action combinations centred on an actual tour of the university campus. A similar high task demands explanation is offered here for the decrements in RWPMT performance in smokers when compared to non-smokers, with previous smokers showing some recovery in this respect. Again, task demands may not explain the variable performance between the groups on the self-reported PM data. Once again the Multi-Process Model of PM (McDaniel & Einstein, 2007) may explain the findings from the RWPMT in terms of the PM task requiring greater effortful processing that might have a more adverse effect on smokers when compared with non-smokers and previous smokers, leading to reduced PM recall in smokers. Also, it is feasible elevated CO levels in smokers could also be used to explain reductions in oxygen to the brain leading to lower performance on the RWPMT task when compared to non-smokers. It is also feasible that previous smokers show some recovery in oxygen levels and related PM performance.

Although the RWPMT was deemed to have face validity and demonstrated good reliability, concurrent validity was not established. This granted, the RWPMT was still sensitive to differences between smokers and non-smokers in the present study, in that smokers performed significantly lower on the RWPMT, although the lack of concurrent validity suggests caution when interpreting the findings. The inconsistent findings across all three studies on the self-reported PM suggest that the pattern of deficits is mixed. Also one has to be careful in reaching a firm conclusion based on only three findings from the objective measures in Studies 1 – 3.

The results from the correlational analyses applied to the smokers revealed no associations between the number of cigarettes used per week, the length of smoking in years, nor between the lifetime usage, and any measure of PM. This is not consistent with the findings from Studies 1 and 2 and does not support the view that any dose related PM deficits exist in smokers, nor any relationship between length of smoking and PM deficits. The implications of these findings are considered in more depth in the General Discussion section.

Since the completion of Studies 1 - 3 a PhD dissertation was published on the web in late 2007 looking at the impact of prolonged smoking upon prospective memory (Rash, 2007). Rash compared a group of deprived smokers, non-deprived smokers and non-smokers on a series of lexical decision tasks within which PM targets were shown and the participants had to respond by pressing a key on the keypad whenever they recognised the symbol. The findings revealed a clear trend on the PM performance, with non-smokers performing best on the PM tasks, with previous smokers performing second-best and current smokers performing worst. The findings from the objective PM measures in studies $1 - 3$ of the present thesis support the findings from Rash in relation to the superior performance shown by non-smokers over smokers on an objective PM task. Together this evidence reinforces the notion that prolonged smoking impairs PM. It should be noted that Rash used a very simple PM task (single key presses to target items) whereas the 3 objective tasks used so far in the present thesis utilised a relatively complex range of action- and time- based PM tasks. Thus it is argued here that the findings from the present thesis are more ecologically valid than those found by Rash.

4.5 Chapter Summary

The present study had three aims. Firstly, to assess self-reported PM lapses in non-smokers, current smokers and previous smokers utilising the PRMQ in order to establish whether there are any consistent self-reported lapses associated with smoking. Secondly, to observe whether the findings from the objective PM tasks used in Studies 1 and 2 could be extended to a real-world objective measure in the form of a Real World Prospective Memory Task (RWPMT). Thirdly, to observe whether smoking cessation results in some recovery of function in PM. Age, gender, mood, strategy use, IQ and other substances used were also controlled for in the analysis. Again the results revealed no significant differences between smokers, non-smokers and previous smokers on any of the subscales of the self-report PRMQ. It was therefore concluded that the use of self-reported PM scales did not produce any consistent findings with regards lapses in PM in relation to prolonged smoking. As was found in Studies 1 and 2, the current study revealed significant differences on the RWPMT, with non-smokers and previous smokers outperforming the smokers on overall performance, but with no significant difference between the non-smokers and previous smokers group. These findings provide additional evidence that prolonged current smoking is associated with impaired PM performance and that smoking cessation from smoking results in some recovery of PM functioning, but again caution needs to be used when making a firm conclusion from such findings. Finally, the current study has revealed that the PM deficits associated with current smoking extend to a naturalistic or real-world scenario – a novel and important finding to the literature.

Chapter 5

Study 4: Does a state of smoking withdrawal have an impact upon PM performance in smokers?

5.1 Introduction

The findings of Study 3 revealed no significant differences between smokers, non-smokers and previous smokers on any of the subscales of the self-report PRMQ measure. However, the finding that smokers performed significantly worse than non-smokers on the RWPMT confirms that persistent smoking impairs PM, a finding that is consistent with the findings of Rash (2007) whose work only appeared in the literature after the completion of Study 3 and is therefore introduced here for comparison purposes. The superior performance of the previous group over smokers suggests a recovery in some function of PM when smoking is stopped. Taken together, the findings from Studies 1 – 3 provide convergent evidence that current smoking impairs PM and that such impairment extends to real-world PM performance, but it should be noted that such evidence is not unequivocal in its support for such a strong conclusion. However, as noted previously, this interpretation needs to be tempered with caution given the inconsistent findings derived from the self-report measures of PM in Studies 1 – 3 (i.e. the PMQ and PRMQ findings) that suggest no consistent perceived PM deficits by smokers. Added to this is the limitation that there is a paucity of standardised published objective measures of PM that can be utilised and therefore the present thesis relied upon 2 of the 3 measures used thus far that were produced in-house. The utilisation of three objective PM tasks (the PRVP, CAMPROMPT and RWPMT) within a smoking

136

paradigm are novel contributions to the literature on the cognitive consequences of smoking.

One issue that emerged after completing studies 1 – 3 and one that has been subsequently explored by the present research was the possibility that some of the findings from the objective measures adopted in the present thesis may have been subject to a potentially serious confound. Specifically, the fact that there was a gap between having smoked a last cigarette and carrying out the objective task of about 20 minutes may have resulted in the smoking participants being in a state of smoking withdrawal when they actually carried out the objective task. Previous studies (Hughes et al., 1992; Parrott et al., 1996; 1998; Sakurai and Kanazawa, 2002) have stated that withdrawal in participants can occur between 10 minutes, 24 hours and 26 days when they state that withdrawal can affect one's cognition and memory performance negatively. It is therefore possible that the findings from the smokers' performance in Studies 1 and 3 were confounded by possible withdrawal effects and not the result of smoking *per se*. It should be noted that this was not the case in Study 2 where the CAMPROMPT was administered within two minutes of their having smoked. However, it is important to note that the findings from all three objective measures revealed the same finding – smokers' performance was consistently poorer than previous and non-smokers, despite the different time scale between smoking a cigarette and the testing phase.

The current study explores this possibility by focusing upon current smokers and comparing two orders of presentation, a) where the self-reports (the RDBQ, PRMQ and HADS) and pre-morbid IQ are presented first, followed by the objective PM task

(producing a gap between having smoked and performance on the PRVP of about 20 minutes); b) where the objective PM task is presented first, followed by the self-reports and pre-morbid IQ (no gap between smoking and the PRVP). This will allow for a comparison of state of smoking withdrawal by counterbalancing the presentation of the objective measure of PM. All smokers will be required to smoke immediately before the start of any test. If there is no difference in recall on the objective PM task comparing presentation order a) and b) then withdrawal effects can be considered not to have an impact upon PM performance. In addition, age, cigarettes last used and how long they had been smoking, other drug use, mood, strategy use and IQ were measured and controlled for in the study.

Rationale for Methodology Adopted.

The choice of the main objective measure of PM in the present study was the Prospective Remembering Video Procedure (PRVP) produced by Jardine 2002. This was chosen for practical purposes. First, since the present study accessed first, second and third year undergraduate psychology students at the university where the research was conducted, it was perfectly feasible that a proportion of these would have carried out the PRVP used in Study 1 (by Forster, 2003), the CAMPROMPT used in Study 2 and the RWPMT used in Study 3. Second, these techniques were also being used by other researchers within the university, thus increasing the likelihood that some of the students would have carried out some of these procedures before. The Jardine PRVP had not been used within the university for several years (since 2002) and its utilisation therefore avoided biases that might have occurred due to practice effects. Given the lack of any consistent findings with the PMQ and

PRMQ from the previous three studies, it was decided that no self-reported PM measure would be used in the remainder of the studies in the present thesis. Covariates in the form age, gender, strategy use, other drug use (including alcohol, cannabis and ecstasy), mood and IQ were again measured (based on the same rationale as considered in Study 3) and included in the analysis.

5.2 Method

Design

The present study employed a non-experimental, existing-groups design. There was one independent factor which had 2 levels: Group 1 who completed the questionnaires first, followed by the PRVP (creating a gap between last cigarette smoked and performance on the PRVP of about 20 minutes), and Group 2 who completed the PRVP first, followed by the questionnaires (no gap between cigarette use and PRVP). Only one main dependent measure was assessed in the form of the total score on the objective Prospective Remembering Video Procedure (PRVP) test. There were ten non-memory covariates measured. These consisted of age (1), gender (2), length of smoking in years (3), number of cigarettes used per week (4), alcohol use in weekly units (6), cannabis use in joints per week (7), and ecstasy (MDMA) use in terms of the number of tablets per week (8), scores on the mood questionnaire for HADS anxiety (9) and depression (10). Co-variation was used to control for differences between the two groups of smokers on the non-memory measures. Each participant was required to smoke immediately prior to the testing. Please note that the NART and the PRMQ were administered as part of the tests to fill the gap between smoking and the completion of the PRVP, but neither was analysed.

Participants

A total of 59 people took part in the study. All were smokers, with a mean age of 22.8 years (SD=5.22, with 26 males and 33 females), who smoked on average 76.9 cigarettes per week (SD=39.1), with a range of between 10 and 200 cigarettes per week (with the most frequently occurring number being 70 and 100 cigarettes per week) and had smoked for an average of 7.12 years (SD= 4.91). They had all last smoked immediately prior to testing. All participants were recruited using an opportunity sampling method and were university undergraduates studying in the North East of England. Some of the participants were paid volunteers whilst others received points as a reward via the University's participation system. All were volunteers.

Materials

The National Adult Reading Test (NART)

The NART provides a measure of pre-morbid IQ (NART: Nelson and Willison, 1991) and was the same measure as used in Studies 2 and 3.

The Recreational Drug Behaviour Questionnaire (RDBQ)

The RDBQ is a self-report measure of recreational drug use, including smoking, alcohol and other substance use. This was the same measure as used in Studies 1-3.

The Hospital Anxiety and Depression Scale (HADS)

This is a self-report questionnaire designed to measure levels of anxiety and depression (Snaith & Zigmund, 1994). This is the same questionnaire as that used in Studies 2 and 3.

The Prospective and Retrospective Memory Questionnaire (PRMQ)

This is a single sheet self-report test developed by Crawford et al., (2003) which measures PM and retrospective memory (RM). This is the same questionnaire as that used in Studies 2 and 3.

The Prospective Remembering Video Procedure (PRVP)

The Prospective Memory Video Procedure (PRVP) - (based on Jardine, 2002) was presented on a CD-ROM and represented an 8 minute video sequence of a walk through a main shopping area in Newcastle upon Tyne similar to that described fully in Study 1. For example, "When you reach BurgerKing" – "Remember to ask about their promotional offer", (See appendix 5 for the full list of items). One point was given for each correct Location – Action combination correctly recalled, with a possible total of 16 points achievable. The higher the score, the better one's PM.

The PRVP was deemed to have face validity in that its aim was to test a person's ability to remember to do particular activities at particular locations on a tour around the university campus, thus tapping into everyday PM. Concurrent validity in the present study was not possible due to the cessation of using the self-reported PM questionnaires. However, concurrent validity for this test has been established in the original study by Jardine 2002 which demonstrated a significant negative correlation between scores on the PRVP and errors reported on the PMQ $(r(51)= -.26, p<.05)$ indicating that the higher the scores on the PRVP, the less errors were reported on the PMQ. In order to demonstrate the PRVP's reliability, a split-half reliability test was conducted on the first half scores (using items $1 - 8$) and the

second half score (items 9 - 16) on the PRVP results. The results of the split-half reliability check showed good reliability [r(59)=0.27, P<.05]. Please note that this was a different PRVP test than the one used in Study 1 (based on Forster, 2003). The purpose for this was to ensure that the participants had not seen this video before in order to reduce any potential practice effects.

Procedures

Ethical approval for the study was provided by the Staff Ethics Committee of the School of Psychology and Sport Sciences at Northumbria University indicating that the approval adhered to the British Psychological Society's ethical guidelines. Each participant was informed of their right to withdraw from the study at any time or have their data destroyed later, if they so wished. They were given an ID code for this purpose. Each participant completed the Consent Form that asked for their name, signature, date, telephone number/e-mail address and included an ID code. Each of the first half of the participants was asked to complete the NART, followed by a response pack, containing the Recreational Drug Behaviour Questionnaire (RDBQ), the Hospital Anxiety and Depression scale (HADS), the Prospective and Retrospective Memory Questionnaire (PRMQ) as a self-report measure of PM, and finally the Prospective Memory Video Procedure (PRVP). Then the other half of the participants completed the same sets tasks but in reverse order – the objective test of the PRVP first and then the self-report tests.

Following completion of these tasks each participant was provided with a copy of the Debriefing sheet that thanked them for their participation and provided further

details of the study. They were reminded of their right to have their data withdrawn from the study at any time by providing their unique ID code (contained on Debriefing sheet). Participants were advised that feedback, in the form of overall findings, could be sought by contacting the researcher or Supervisor after the end of September, 2008. The whole testing time took approximately 50-60 minutes per participant and the participants were tested on an individual basis in a quiet laboratory setting.

5.3 Results

The results were collated and computed using SPSS version 15. The data was analysed across the two levels of condition as the independent factor: condition 1 - (completing the questionnaires followed by the PRVP video task) and condition 2 – (completing the PRVP video task then completing the questionnaires. Table 5.1 below represents the means and standard deviations for the non-memory measures of other drug use, and mood for depression and anxiety. Please note that other drug use (other than cannabis, ecstasy, alcohol) was miniscule and was not calculated or included in the analysis.

Table 5.1   Means and Standard Deviations for non-memory measures of weekly units of alcohol, weekly use – joints of cannabis, the weekly use of ecstasy tablets, measures of Depression and levels of Anxiety across the two conditions.

Conditions		units of alcohol/week	Cannabis joints/week	Ecstasy pills/ week	HADS Dep	HADS Anx
1: Q'S then Video N = 30	Means	15.8	0.17	0.008	3.93	8.93
	Std Devn	12.941	0.43	0.045	2.586	3.433
2: Video then Q's N = 29	Means	28.76	0.33	0.21	3.41	8.24
	Std Devn	20.366	0.57	0.47	2.556	3.563

Table 5.2 below presents the relationship between age, gender, number of cigarettes used, length of smoking in years, units of alcohol use per week, cannabis use per week, ecstasy use per week, anxiety and depression, in relation to the main dependent measure which was scores on the PRVP. Again it was decided to adopt an ultra-conservative approach to control for any variations across the 2 conditions on the covariates, which meant that all of the covariates were incorporated into the ANCOVA, regardless of whether they were significantly related to the dependent measure or not

Table 5.2   Shows the p values for the relationship between those covariates displaying significant values and each of the dependent measures controlled for in the following ANCOVAs.

	Age	Gender	Number of cigarettes	Length of smoking	Units of alcohol	Cannabis per week	Ecstasy per week	Anxiety score	Depression score
PRVP	NS	NS	NS	P<.05	NS	NS	NS	NS	NS

Figure 5.1 below shows the mean scores and standard deviations for the two groups of smokers who completed the PRVP objective task.
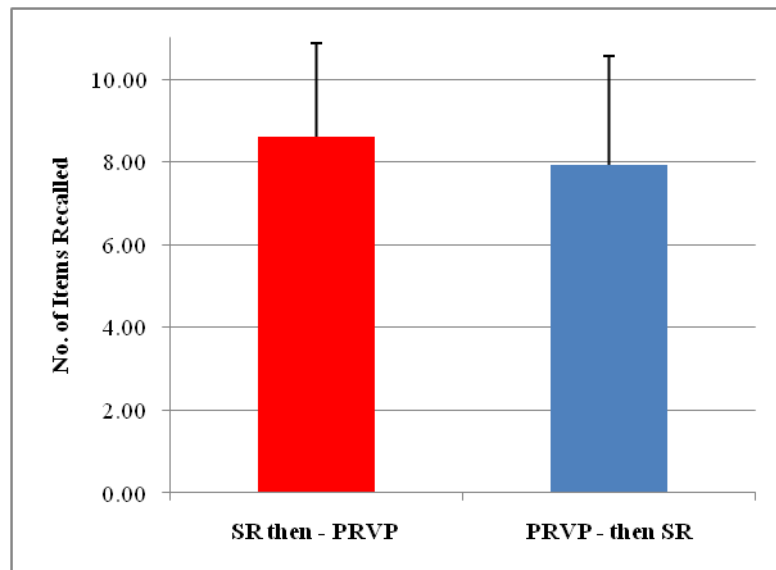
Figure 5.1 Means and Standard Deviations for the correct number of location-action combinations recalled from the Prospective Remembering Video Procedure (PRVP) across two conditions – Self reports (SR) first followed by the PRVP and PRVP followed by the Self reports (SR).

A Univariate Analysis of Co-Variance (ANCOVA), incorporating the non-memory measures of age, gender, length of smoking, the number of cigarettes smoked per week, units of alcohol, use of cannabis, use of ecstasy, levels of Anxiety, levels of Depression were used as covariates, was applied to the data across the two conditions (PRVP first followed by SR compared with SR first followed by PRVP). The results revealed no significant main effect of condition on the objective PRVP measure [$F (1, 48) = 1.06, p=.30$].

Correlational Analyses.

In addition to the main analyses three sets of correlations were carried out: one that assessed the association between the number of cigarettes smoked and the objective measures of PM, a second set that assessed the association between how long the person had smoked and the objective measures of PM and a third set that assessed the association between the lifetime usage of cigarettes and the objective

145

measures of PM across all current smokers from the study. The purpose of these correlational analyses was to observe whether the number of cigarettes smoked, how long the person had been smoking and lifetime cigarette use in the current smokers was associated with a particular pattern of memory lapses on the PRVP.

A set of Pearson Product Moment correlations revealed no significant correlation between the number of cigarettes smoked and performance on the PRVP ($r(59)=$ -0.06, $p=.61$), nor between lifetime usage and scores on the PRVP ($r(59)=-0.19$, $p=.13$). However, the length of smoking was negatively related to scores on the PRVP ($r(59)=-0.30$, $p<.05$) indicating that the longer one has smoked the worse their performance on the PRVP. The scatterplot representing the relationship between lifetime usage and scores on the PRVP is depicted in Figure 5.2.
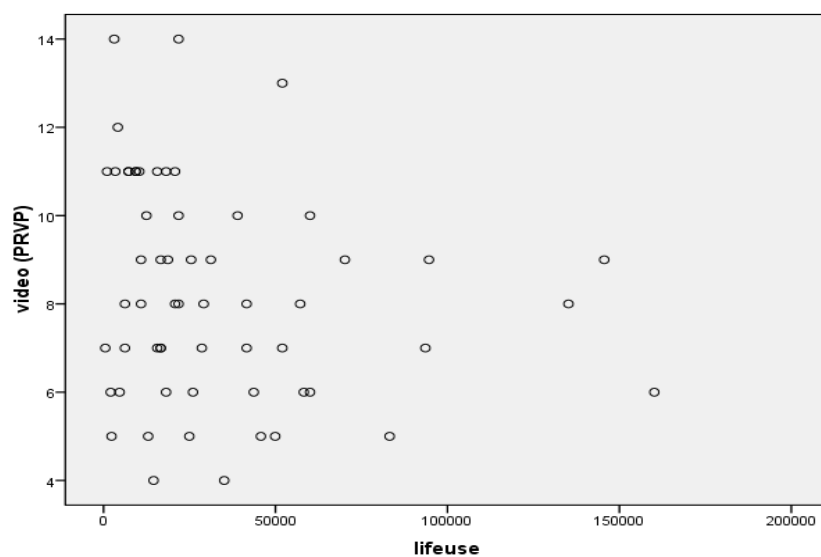
Figure 5.2   A significant negative correlation between the length of time the person had smoked and scores on the PRVP, indicating that the longer one had smoked the poorer their performance was on the PRVP.

5.4 Discussion

The aim of the present study was to explore whether a gap of about 20 minutes prior to carrying out the objective PM task produced a state of smoking withdrawal in smokers in Studies 1 and 3 which may have contributed to their poor performance on the PM tasks. This was achieved by focusing upon smokers and comparing two orders of presentation, a) where the self-reports and pre-morbid IQ are presented first, followed by the objective PM task; b) where the objective PM task is presented first, followed by the self-reports and pre-morbid IQ. This enabled a comparison of state of withdrawal by counterbalancing the presentation of the objective measure of PM. Study 4 showed no significant difference in the PRVP performance between the two orders of presentation. It is concluded that having a gap of about 20 minutes between having smoked and performing the objective PM task does not adversely affect smokers' PM as a result of them being in a state of smoking withdrawal. Therefore the poor performance on the objective PM measures found in smokers from the previous studies cannot be due to withdrawal effects - rather they are the direct result of persistent smoking.

In addition, the correlational analyses revealed that the number of cigarettes used per week and lifetime usage was not related to scores on the PRVP, with just the length of time having smoked being negatively related to performance on the PRVP. Again this finding does not provide support for dose-related PM deficits in smoking, rather it appears to be the length of time spent smoking that predicted poorer performance on the objective measure of PM. As stated in previous chapters, correlations between factors does not imply a causal relationship and does not allow

one to judge whether any particular method (e.g. the PRVP in the present study) is preferable to any other method of measuring PM. Again the implications of these findings are considered in more depth in the general Discussion section.

Although it is concluded that having a gap of about 20 minutes between having last smoked a cigarette and performing the objective PM task (the PRVP) does not adversely affect smokers' performance, the study does have its limitations. Although the timeframe used here as a means of detecting a state of smoking withdrawal was 20 minutes, it is possible that this was too short a timeframe to use. As discussed in the introduction to the present study, states of withdrawal in participants can occur between 10 minutes, 24 hours and 26 days when it is possible that the effects of withdrawal can have a deleterious impact upon cognition and memory (Hughes et al., 1992; Parrott et al., 1998, 1996; Sakurai & Kanazawa, 2002). Therefore, this may have introduced a confound into the present study. Future research should consider this and compare differing states of smoking withdrawal and their impact upon PM performances in smokers, such as minutes, hours, and possibly even days, being compared. This would throw light on what impact varying degrees of withdrawal might have upon PM performance.

5.5 Chapter Summary

It was noted that poor performance of the smoking groups on the objective PM tasks adopted in the previous studies could have been due to them being in a state of smoking withdrawal and not due to the damage caused by their long-term smoking *per se*. The present study explored this by comparing two orders of presentation to smokers, a) self-reports and the IQ tests were presented first, followed by the objective PM task (introducing a gap of about 20 minutes) and b) where the objective PM task was presented first, followed by the self-reports and pre-morbid IQ (no gap). This allowed for an evaluation of state of withdrawal by compensating the production of the objective measure of PM. After controlling for other non-memory covariates, no significant difference was found between the two orders of presentation on performance on the PRVP. It was concluded that including a gap between smoking and performance on the objective PM measure did not induce a state of smoking withdrawal. The findings from Studies 1 and 3 are therefore due to smoking *per se* and not the result of any confound associated with any state of withdrawal.

Chapter 6

Study 5: A comparison of Social (binge) smokers and Regular (daily) smokers on PM using the PRVP

6.1 Introduction

Study 5 explores a very recent focus point (but still under-researched) relating to the adverse effects of smoking is the notion of social (sometimes referred to as binge) smoking. A social smoker refers to a person who smokes a quantity of cigarettes within a couple of sessions per week, often associated with social settings. Waters et al (2006) stated that "Social smoking is a newly identified phenomenon in the young adult population that is poorly understood", whilst other researchers (Whitesel, 2003) have further suggested that social smokers perceive themselves as controlled smokers who are able to confine their smoking to social situations (e.g. going out on a weekend with friends) and therefore do not fit the traditional addiction model of smoking associated with regular daily smokers. The same point was also highlighted in a US study which found that young people distinguished between social and regular (daily) smokers by believing that social smokers were themselves in control of their smoking habit whereas the regular smokers were older, addicted smokers (Mermelstein, 2003). The notion of social or binge smoking was first introduced by Spiro in 2003 when he reported to the British Lung Foundation that: "People go out and smoke socially on a Friday or Saturday night and get through about 20 or 30 cigarettes." Spiro's quote reflects a concern that 'social smoking' may have more adverse effects on the system because one is introducing a large amount of nicotine and other chemicals into the system in a short period of time.

The distinction between social and regular (daily) smokers is evident in recent research into the smoking habits of young people. For example, a recent study by Amos and Bancroft (2006) reviewed Scottish youths aged 17-18 year old regarding their smoking behaviour and identified regular daily smokers and 'social smokers' who smoked intermittently with friends but did not classify themselves as regular smokers. However, no research to date has compared whether binge smoking has more or less of a detrimental effect upon cognition.

The present study explored the notion of whether the pattern of smoking, (i.e. social versus regular (daily)), had a differential impact upon prospective memory. Two groups of smokers were compared, one group comprising Social Smokers who smoked between 1 - 3 social occasions per week and smoked up to a maximum of 30 cigarettes within the week, and a second group comprising Regular Daily Smokers who smoked on a daily basis and smoked in excess of 30 cigarettes within a week. The Prospective Remembering Video Procedure (PRVP: as used in Study 4) was utilised as the objective measure of PM. All participants were required to smoke immediately before the start of testing. Since there has not been any previous research focusing upon what Social versus Regular smoking will have upon PM, no specific prediction will be made. In addition, age, cigarettes last used and how long they had been smoking, other drug use, mood, strategy use and IQ were measured and controlled for in the study.

Rationale for Methodology Adopted.

The choice of the main objective measure of PM in the present study was the Prospective Remembering Video Procedure (PRVP) produced by Jardine 2002. This methodology was chosen for its convenience, in that the equipment was already set-up in a testing room, was quick to administer and, unlike the Forster (2003) PRVP, was not being widely used for a range of studies around the university at that time. Predominantly non-psychology students were accessed to further ensure that they had not seen the Jardine PRVP beforehand therefore reducing potential practice effects. The PRVP was seen as a more ecologically valid measure of PM when compared with CAMPROMPT due to the inclusion of everyday action-locations combinations. It was also decided that a real-world PM task would be used for the final study in this series, as this was believed to represent the ultimate assessment of how PM processes may vary between regular and social smokers within a real-world context. Given the lack of any consistent findings with the PMQ and PRMQ from the previous three studies, it was decided that no self-reported PM measure would be used in the remainder of the studies in the present thesis. Covariates in the form age, gender, other drug use (including alcohol, cannabis and ecstasy), mood and IQ were again measured (based on the same rationale as considered in Study 4) and included in the analysis.

6.2 Method

Design

The present study employed a non-experimental, existing-groups design. There was one independent factor which had 2 levels: Regular Smokers (those who smoked

more than 30 cigarettes per week and smoked daily) and Social Smokers (those who only smoked on social occasions and less than 30 per week). There was one dependent measure consisting of the total score on the objective Prospective Remembering Video Procedure (PRVP) test. There were ten non-memory covariates measured. These consisted of age (1), gender, (2), length of smoking in years (3), number of cigarettes used per week (4), alcohol use in weekly units (5), cannabis use in joints per week (6), and ecstasy (MDMA) use in terms of the number of tablets per week (7), scores on the HADS mood questionnaire for anxiety (8) and depression (9). Finally, the scores on the pre-morbid measure of IQ in the form of the NART scores (10). Please note that other drug use (other than cannabis, ecstasy, alcohol) was miniscule and was not calculated or included in the analysis. Co-variation was used to control for differences between the two groups of smokers on the non-memory covariates. Each participant was required to smoke immediately prior to the testing, which ruled out the possibility of the smokers suffering from any state of withdrawal – as discussed in Study 4.

Participants

A total of 63 people took part in the study. There were 30 regular smokers (those who smoked more than 30 cigarettes per week and smoked daily) with a mean age of 23.1 years (SD=6.11), with 7 males and 23 females, who smoked on average 84.9 cigarettes per week (SD=39.8), with a range of between 40 and 200 cigarettes per week (with the most frequently occurring numbers being 70, 80 and 100 cigarettes per week) and had smoked for an average of 7.9 years (SD= 5.03). There were 33 social smokers (those who only smoked on social occasions and less than 30 per week) with

a mean age of 20.1 years (SD=5.4), with 11 males and 22 females, who smoked on average 18.7 cigarettes per week (SD=14.1), with a range of between 2 and 30 cigarettes per week (with the most frequently occurring number being 15 cigarettes per week) and had smoked for an average of 3.79 years (SD= 2.13). They had all last smoked immediately prior to testing. All participants were recruited using an opportunity sampling method and were university undergraduates studying in the North East of England. Some of the participants were paid volunteers whilst others received points as a reward via the University's participation system. All were volunteers.

Materials

The Prospective Remembering Video Procedure (PRVP)

The Prospective Memory Video Procedure (PRVP) - (based on Jardine, 2002) was presented on a CD-ROM and represents an 8 minute video sequence of a walk through a main shopping area in Newcastle which was the same video clip as used in Study 4. The validity for this test was established in Study 4. In order to demonstrate the PRVP's reliability, a split-half reliability test was conducted on the first half scores (using items 1 – 8) and the second half score (items 9 - 16) on the PRVP from the 63 participants. The results of the split-half reliability check showed good reliability [r(63)=0.32, p<.01].

The Recreational Drug Behaviour Questionnaire (RDBQ)

The RDBQ is a self-report measure of recreational drug use, including smoking, alcohol and other substance use. This is the same test as that used in previous studies,

but with variations made to accommodate the requirements used to determine the difference between regular smokers and social smokers, specifically asking the person to identify whether they smoked daily, or smoked socially (in which case they listed how many cigarettes they smoked on how many occasions across a week).

The Hospital Anxiety and Depression Scale (HADS)

This is a self-report questionnaire designed to measure levels of anxiety and depression (Snaith and Zigmund, 1994) and was the same test as used in studies 2-4.

The National Adult Reading Test (NART)

The NART provides a measure of pre-morbid IQ (NART: Nelson and Willison, 1991). This is the same test as that used in previous studies.

Procedure

Ethical approval for the study was provided by the Staff Ethics Committee of the School of Psychology and Sport Sciences at Northumbria University indicating that the approval adhered to the British Psychological Society's ethical guidelines. Each participant was informed of their right to withdraw from the study at any time or have their data destroyed later, if they so wished, for which they selected an ID code. Each participant completed the Consent Form that asked for their name, signature, date, telephone number/e-mail address and to tick one of two boxes indicating whether they were a social or regular smoker and included their ID code (similar to that used in the previous studies). Each of the participants was asked to complete the Prospective Remembering Video Procedure (PRVP) followed by a response pack,

containing the Recreational Drug Behaviour Questionnaire (RDBQ), the Hospital Anxiety and Depression scale, and finally the NART used as a measure of pre-morbid IQ. Following completion of these tasks each participant was provided with a copy of the Debriefing sheet that thanked them for their participation. They were reminded of their right to have their data withdrawn from the study at any time by providing their unique ID code (highlighted on the Debriefing sheet). Participants were advised that feedback, in the form of overall findings, could be sought by contacting the researcher or Supervisor after the end of November 2008. The whole testing time took approximately 30 minutes per participant and the participants were tested on an individual basis.

6.3 Results

The results were collated and computed using SPSS version 15. The data was analysed across two levels of condition as the independent factors: Regular Smokers and Social Smokers. Table 6.1 below represents the means and standard deviations for the non-memory measures of alcohol, cannabis and ecstasy use per week. Table 6.2 below represents the means and standard deviations for depression and anxiety (HADS) and IQ (NART).

Table 6.1   Means and Standard Deviations for non-memory measures of age, alcohol use per week, cannabis use and ecstasy use per week as reported by regular and social smokers.

Condition		Alcohol units per week	Cannabis joints per week	Ecstasy pills per week
Regular N = 30	Mean	15.8	0.33	0.06
	Std Dev	12.94	0.66	0.20
Social N = 33	Mean	23.48	0.36	0.09
	Std Dev	18.4	0.48	0.29

Table 6.2 Means and Standard Deviations for memory measures: levels of Mood (Depression), levels of Mood (Anxiety) and measures of NART converted scores (I.Q) as reported by regular and social smokers.

Condition		HADS Depression	HADS Anxiety	NART
Regular	Mean	3.93	8.93	121
N = 30	Std Dev	2.59	3.43	7.17
Social	Mean	2.33	6.94	119
N = 33	Std Dev	1.76	2.74	3.18

Table 6.3 below presents the relationship between age, gender, the number of cigarettes used, the length of smoking in years, the number of units of alcohol used per week, the amount of cannabis used per week, the number of ecstasy tablets used per week, anxiety and depression scores, and scores on the NART, in relation to the main dependent measure which was scores on the PRVP. Again it was decided to adopt an ultra-conservative approach to control for any variations across the 2 conditions on the covariates, which meant that all of the covariates were incorporated into the ANCOVA, regardless of whether they were significantly related to the dependent measure or not.

Table 6.3 Shows the p values for the relationship between those covariates displaying significant values and each of the dependent measures controlled for in the following ANCOVAs.

	Age	Gender	Number of cigarettes	Length of smoking	Units of alcohol	Cannabis per week	Ecstasy per week	Anxiety score	Depression score	NART
PRVP	NS	P<.05	NS	NS	NS	NS	NS	NS	NS	NS

Figure 6.1 (below) displays the means and standard deviations for the two groups of smokers: Regular smokers and Social smokers on the PRVP scores.

Figure 6.1 Means and Standard Deviations for the correct number of recalled items from the Prospective Remembering Video Procedure for Regular Smokers and Social Smokers.

A Univariate Analysis of Co-Variance (ANCOVA), controlling for age, gender, the number of cigarettes smoked per week, cigarettes last used and how long they had been smoking, alcohol, cannabis, ecstasy, anxiety and depression scores, and IQ, was applied to the PRVP data across the two conditions of smokers (binge and regular smokers). The result of the ANCOVA revealed no significant main effect of condition on the objective PRVP measure [$F_{(1, 51)} = 0.01$, $p=.91$]. From the results of the PRVP it is clear that there was no significant difference between regular and social smokers on the PRVP.

Correlational Analyses.

In addition to the main analyses three sets of correlations were carried out: one that assessed the association between the number of cigarettes smoked and the PRVP, a second set that assessed the association between how long the person had smoked and the PRVP, and a third set that assessed the association between the

lifetime usage of cigarettes and the PRVP, across all current smokers from the study. The purpose of these correlational analyses was to observe whether the number of cigarettes smoked, how long the person had been smoking and lifetime cigarette use in the current smokers was associated with performance on the PRVP. A set of Pearson Product Moment correlations revealed; no significant correlation between the number of cigarettes used per week and scores on the PRVP ($r(63)=0.05$, $p=.67$), nor between the length of smoking and scores on the PRVP ($r(63)=-0.18$, $p=.15$), nor between lifetime usage of cigarettes and scores on the PRVP ($r(63)=-0.06$, $p=.64$).

6.4 Discussion

The findings of Study 5 revealed no significant differences between Regular Smokers and Social Smokers on the scores of the PRVP. This was found after controlling for non-memory covariates. It can be concluded that the pattern of smoking in terms of whether one is a Regular (daily) or Social (binge) smoker does not have a differential effect on PM performance. Given the findings from Studies 1 – 3 smokers performed significantly worse than non-smokers on all of the objective PM tasks, combined with the observation that social and regular smokers performed at a similar level on the PRVP task (similar to those levels achieved by the smokers on the objective measures from Studies 1 – 3), it can be concluded that it is smoking *per se* that appears to damage PM performance. In addition, the correlational analyses revealed that the number of cigarettes used per week, the length of time one has smoked, and the overall lifetime usage, were not related to scores on the PRVP. Again this finding does not provide support for dose-related PM deficits in smoking. The implications of these findings are considered in more depth in the general

Discussion section. Since both groups were smokers, a task demand hypothesis or elevated CO levels theory is not appropriate for the present study.

Study 5 has produced interesting results that support the notion that smoking *per se* produces deficits in everyday PM, regardless of whether one is a Social or a Regular smoker. Current research suggests that the notion of social smoking is a relatively new phenomenon to our understanding of public health and is seen as a growing problem within society particularly within younger populations, e.g. college students who often drink alcohol alongside smoking (Amos & Bancroft, 2006), therefore increasing the potential risk to their health and well being (Moran, Wechsler and Rigotti, 2009). Before any conclusion can be reached with regards whether binge smoking has a greater or lesser impact upon PM than regular smoking, it would be prudent to carry out a further study using a different methodology. Study 6 addressed this by comparing Social and Regular smokers on a real-world PM task. A real-world study was chosen because it provides a better reflection of what smokers do in their everyday activity.

6.5 Chapter Summary

Study 5 explored a very recent focal point, still little researched, relating to the adverse effects of smoking that is known as social or binge smoking. Since social or binge smoking is seen as an increasing problem within society, particularly among younger people (e.g. Spiro, 2003), it is important to observe what impact this pattern of smoking might have upon everyday PM. Study 5 explored the notion of whether the pattern of smoking, (i.e. social versus regular (daily)), had a differential impact upon PM. Social Smokers (those who smoked between 1 - 3 social occasions per week, up to a maximum of 30 cigarettes), were compared to Regular Daily Smokers (those who smoked on a daily basis and smoked in excess of 30 cigarettes within a week). The Prospective Remembering Video Procedure (PRVP: as used in Study 4) was utilised as the objective measure of PM. All participants were required to smoke immediately before the start of testing. Since there has not been any previous research focusing upon what Social versus Regular smoking will have upon PM, no specific prediction will be made. In addition, age, gender, cigarettes last used and how long they had been smoking, other drug use, mood, strategy use and IQ were measured and controlled for in the study. The findings of Study 5 revealed no significant differences between Regular Smokers and Social Smokers on the scores of the PRVP. It has produced interesting results that support the view that smoking *per se* has a damaging effect on PM regardless of whether a person is a Social or Regular smoker.

Chapter 7

Study 6: Do Social (binge) smokers and Regular (daily) smokers differ on a RWPRT?

7.1 Introduction

Study 5 was designed to observe whether different patterns of smoking produced differential effects upon prospective memory. Social smokers and regular daily smokers were compared on their performance on the Prospective Remembering Video Procedure (PRVP). The finding from a one-way ANCOVA revealed that, after controlling for a range of covariates, no significant difference between these two groups in terms of their performance on the PRVP, suggesting that it is smoking *per se* that damages PM (as demonstrated in Studies 1 – 3) and not a particular type of smoking pattern. This finding does not support the view that social or binge smoking has a greater detrimental impact upon the smoker, at least in terms of PM. This is a new finding in the literature and warrants further testing in order to verify whether there is consistency.

It was also important to observe whether such a finding extends to a real-world scenario by utilising a Real-World Prospective Remembering Task (RWPRT). As stated in the discussion of Study 5, a number of researchers (Amos & Bancroft, 2006; Moran, Wechsler and Rigotti, 2009) perceive social or binge smoking to be a growing problem within society, particularly among younger adults who often drink alcohol alongside smoking. It is therefore important to assess this pattern of smoking within a real-world context. In order to make the RWPRT more ecologically valid

and in line with current thinking in relation to naturalistic PM tasks (see McDaniel & Einstein, 2007) the RWPRT used in the present study included two delays in the procedure. One delay occurred between the completion of the first two sets of action-location combinations (a 25 minute delay) and the next set of these combinations, with a further delay of 24 hours after the final set of action-location combinations, with the requirement of the participant to email the researcher with their name and ID code. Since the real world often includes delays it was felt that these additions to the procedure would therefore make the task more akin to what happens in the real world. Once again, age, the number of cigarettes used per week and length of smoking in years, the use of alcohol, cannabis and ecstasy across the week, other drug use, levels of anxiety and depression, and a measure of pre-morbid IQ were measured and incorporated as covariates into the main analysis.

Study 5 observed no significant differences between social and regular smokers on a laboratory-based PRVP task. Therefore if social smoking does not lead to any greater impairments in PM the current study should demonstrate no significant difference between social and regular smokers upon a RWPMT.

Rationale for Methodology Adopted.

Study 6 adopted a Real World Prospective Remembering Task (RWPRT) as an objective measure of PM, which required each participant to remember 16 actions at 16 different locations whilst being led around a tour of the University Campus by the researcher. This task was adopted in order to test whether regular and social smokers differed within a real world context, a move welcomed by current

researchers within the field of PM (McDaniel & Einstein, 2007). Again it is suggested here that the use of the RWPRT was seen as more ecologically valid than the CAMPROMPT or PRVP methods. Given the lack of any consistent findings with the PMQ and PRMQ from studies 1 - 3, it was decided that no self-reported PM measure would be used in the current study. Covariates in the form age, gender, other drug use (including alcohol, cannabis and ecstasy), mood and IQ were again measured (based on the same rationale as considered in Study 5) and included in the analysis.

7.2 Method

Pilot Study

The pilot study was also conducted to test whether floor or ceiling effects were evident in the data and whether the procedure was easily understood in terms of its operational procedure. Five female and five male smokers were tested, with a mean age of 22.6 years (SD=1.43). The participants were an opportunity sample selected from students studying at a North-Eastern University. The RWPRT consisted of each participant being provided with a list of 15 location-action combinations for a two minute rehearsal period before they were taken on an actual tour around the university campus with the specific instructions that they should remember each location-action combination. For example, "When you reach the Library" – "Remember to: text a friend, or check your library account." The actual tour consisted of three parts. Firstly, the participant was taken to the library where they had to remember 4 items associated with that location, then onto to the student Habita bar where they had to remember 4 further items. The participant then returned

to the testing room and completed the other questionnaires and the NART, introducing a delay of around 15 minutes. Following this delay the participant was taken to the university shop where they had to remember a further 4 items at this location. Three additional items were added to the Location-Action sheet whereby each person was first asked to remember to declare to the researcher the whereabouts of a piece of paper he (the researcher) had placed in his pocket before testing began. The final two items consisted of instructions that the participant should contact the researcher after a further 24 hours after having completed the action-location combinations, by e-mail and were requested to provide their name and the ID code they had selected for the testing on the previous day. (Further details of these items are presented in Appendix 6). It should be noted that this was a different real-world PM task than that used in Study 3. The reason for this was to introduce more realistic elements into the task here, such as the incorporation of delays between sets of items, as well as requiring the participant to remember multiple items at each location. This was seen as increasing the ecological validity of the task compared to Study 3.

For the pilot study the score was the correct number of location-action combinations recalled in total from a maximum of 15. The results of the pilot study revealed an average score of 10.6 (SD=2.06) location-action/memory combinations (Range from 7 – 13) with nobody achieving greater than 13 as a maximum score. It was therefore concluded that no systematic floor or ceiling effects were evident in the procedure. Qualitative feedback indicated that there were no significant problems in understanding the instructions or procedure and therefore the operational aspects

of the task were satisfactory. The RWPRT was designated to be used in the main study.

Design

The present study employed a non-experimental, existing-groups design. There was one independent factor which had 2 levels: Regular Smokers (those who smoked more than 30 cigarettes per week and smoked daily) and Social Smokers (those who had only smoked on social occasions and less than 30 per week). There were four dependent measures consisting of the following: the total score on the objective Real World Prospective Remembering Task (RWPRT) (1), the total score for the RWPRT for the 8 items before the delay (2), the total score for the RWPRT for the 5 items after the delay (3), and finally the total score for the RWPRT for the 2 items recalled 24 hours after completing the testing (4). There were ten non-memory covariates measured. These consisted of age (1), gender (2), length of smoking in years (3), number of cigarettes used per week (4), alcohol use in weekly units (5), cannabis use in joints per week (6), and ecstasy (MDMA) use in terms of the number of tablets per week (7), scores on the mood questionnaire for HADS anxiety (8) and depression (9). Finally, the scores on the pre-morbid measure of IQ in the form of the NART scores (10). Please note that other drug use (other than cannabis, ecstasy, alcohol) was miniscule and was not calculated or included in the analysis. Co-variation was used to control for differences between the two groups of smokers on the non-memory measures. Each participant was required to smoke immediately prior to the testing, which ruled out the possibility of the smokers suffering from any state of withdrawal – as discussed in Study 4.

Participants

A total of 60 people took part in the study. There were 30 regular smokers with a mean age of 23.0 years (SD=3.35), with 17 males and 13 females, who smoked on average 85.6 cigarettes per week (SD=49.4), with a range of between 35 and 250 cigarettes per week (with the most frequently occurring numbers being 70 and 140 per week) and had smoked for an average of 6.08 years (SD= 5.07). There were 30 social smokers with a mean age of 22.4 years (SD=3.02), with 12 males and 18 females, who smoked on average 21.4 cigarettes per week (SD=13.0), with a range of between 4 and 30 cigarettes per week (with the most frequently occurring numbers being 20 and 30 cigarettes per week) and had smoked for an average of 5.43 years (SD= 3.09). They had all last smoked immediately prior to testing. All participants were recruited using an opportunity sampling method and were university undergraduates studying in the North East of England. Some of the participants were paid whilst others received points as a reward via the University's participation system. All were volunteers.

Materials

The Recreational Drug Behaviour Questionnaire (RDBQ)

The RDBQ is a self-report measure of recreational drug use, including smoking, alcohol and other substance use. This was the same questionnaire as used in previous Studies.

The Hospital Anxiety and Depression Scale (HADS)

This is a self-report questionnaire designed to measure levels of anxiety and depression (Snaith and Zigmund, 1994). This was the same questionnaire as that used in previous studies.

The National Adult Reading Test (NART)

The NART provides a measure of pre-morbid IQ (NART: Nelson and Willison, 1991). This is the same test as that used in previous studies.

Real World Prospective Remembering Task (RWPRT)

The RWPRT was the same test as developed in the pilot study (see previous section for full details of test). The incorporation of delays between sets of items, as well as requiring the participant to remember multiple items at each location were included in this test because it was thought that this best reflects what happens within a real world scenario. It was seen as increasing the ecological validity of the task compared to Study 3 and making the task more akin to what happens in the real world (where delays and interruptions may occur).

The scoring for the main RWPRT was split into 4 types of dependent measures: the total RWPRT score out of a maximum of 15 items; the total RWPRT score for items appearing before the delay out of a maximum of 8 combinations; the total RWPRT score for items appearing after the delay out of a maximum of 4 combinations and 1 reminder (return the piece of paper at end of procedure); and finally the total RWPRT score for items to be remembered 24 hours following the

testing period out of a maximum of 2 combinations. (See Appendix 6 for full set of the location-action/memory combinations).

The RWPRT was deemed to have face validity in that its aim was to test a person's ability to remember to do particular activities at particular locations on a tour around the university campus, thus tapping into everyday PM and it should be noted that the use of more naturalistic studies of this type is a welcomed move in terms of current research thinking within the field of PM (McDaniel & Einstein, 2007). Concurrent validity in the present study was not possible due to the cessation of using the self-reported PM questionnaires. In order to demonstrate the RWPRT's reliability, a split-half reliability test was conducted on the first half scores (using items $1 - 8$) and the second half score (items 9 - 15) on the RWPRT result from the 60 participants from the study. The results of the split-half reliability check showed good reliability [r(60)=0.42, P<.001].

Procedure

Ethical approval for the study was provided by the Staff Ethics Committee of the School of Psychology and Sport Sciences at Northumbria University indicating that the approval adhered to the British Psychological Society's ethical guidelines. Each participant was informed of their right to withdraw from the study at any time or have their data destroyed later if they so wished, for which they were given an ID. Each participant completed the Consent Form that asked for their name, signature, date, telephone number/e-mail address and to tick one of two boxes indicating whether they were a social or regular smoke and included their ID code (similar to

that used in the previous studies. Each participant was then administered the real-world PM task as described above. Following completion of this each participant was provided with a copy of the Debriefing sheet that thanked them for their participation. The form also advised that feedback, in the form of overall findings, could be sought by contacting the researcher or Supervisor after the end of June, 2009. The whole testing time took approximately 50-55 minutes per participant and the participants were tested on an individual basis.

7.2 Results

The results were collated and computed using SPSS version 15. Table 7.1 below represents the means and standard deviations for the non-memory measures of alcohol, cannabis and ecstasy use per week across regular and social smokers. Table 7.2 below represents the means and standard deviations for depression and anxiety (HADS) and IQ (NART) across regular and social smokers.

Table 7.1 Means and Standard Deviations for non-memory measures of age, alcohol use per week, cannabis use and ecstasy use per week as reported by regular and social smokers.

Condition		Alcohol units per week	Cannabis joints per week	Ecstasy pills per week
Regular N = 30	Mean	23.3	0.40	0.15
	Std Dev	17.9	0.49	0.35
Social N = 30	Mean	32.0	0.25	0.04
	Std Dev	15.9	0.37	0.18

Table 7.2 Means and Standard Deviations for memory measures: Mood levels (Depression), Mood levels (Anxiety) and measures of NART converted scores (I.Q) reported by regular and social smokers.

Condition		HADS Depression	HADS Anxiety	NART
Regular N = 30	Mean	3.10	6.50	119
	Std Dev	1.97	3.96	3.89
Social N = 30	Mean	2.47	7.47	119
	Std Dev	2.04	3.03	2.65

Table 7.3 below presents the relationship between age, gender, number of cigarettes used, length of smoking in years, units of alcohol use per week, cannabis use per week, ecstasy use per week, anxiety and depression, and scores on the NART, in relation to the main dependent measure which was scores on the RWPRT. Again it was decided to adopt an ultra-conservative approach to control for any variations across the 2 conditions on the covariates, which meant that all of the covariates were incorporated into the ANCOVA, regardless of whether they were significantly related to the dependent measure or not.

Table 7.3 Shows the p values for the relationship between those covariates displaying significant values and each of the dependent measures controlled for in the following ANCOVAs.

	Age	Gender	No. of cigarettes	Length/ smoking	Units of alcohol	Cannabis per week	Ecstasy per week	Anxiety score	Depression score	NART
PRVP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Figure 7.1 (below) displays the means and standard deviations for the two groups of smokers: Regular smokers and Social smokers on the RWPRT total scores (out of a maximum of 15 items), the pre-delay scores (out of a maximum of 8 action-location combinations), the post delay scores (out of a maximum of 4 action-location combinations and 1 additional item to-be-remembered at the end of the procedure), and the 2 scores obtained by contacting the researcher within the following 24 hours of their participation in the study.
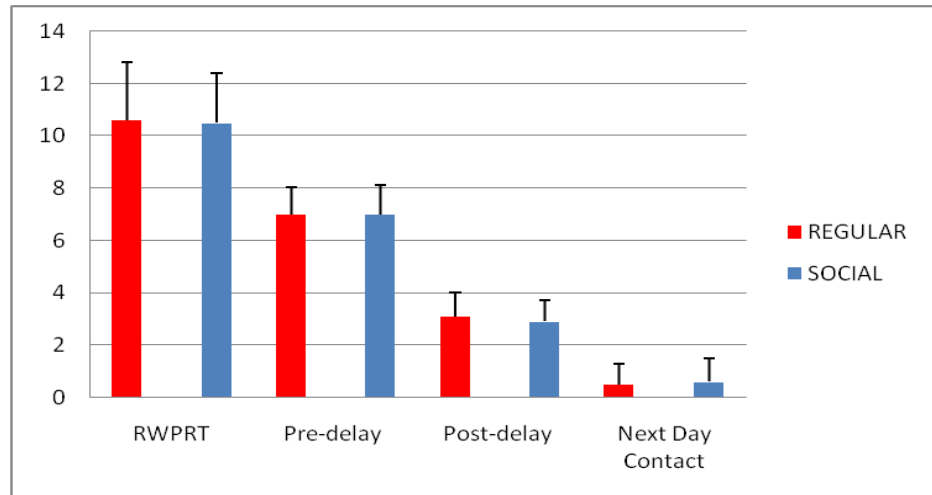
Fig. 7.1 Means and Standard Deviations for the correct number of recalled items from the Real-World Prospective Remembering Task Total scores (RWPRT), Pre and Post Delay, and Next Day Contact scores, for Regular Smokers and Social Smokers.

A Univariate Analysis of Covariance (ANCOVA), controlling for age, gender, the number of cigarettes smoked per week, cigarettes last used and how long they had been smoking, alcohol, cannabis, ecstasy, anxiety and depression scores, and IQ, was applied to the two conditions of smokers (binge and regular smokers) on the RWPRT data for the total scores, total before delay scores, total after delay scores and total after 24 hours after testing. The result of the ANCOVA revealed no significant main effect of condition on the RWPRT data for the total scores [F $(1,48)=0.05$, p=.81], total before delay scores [F $(1,48)=0.16$, p=.69]., total after delay scores [F $(1,48)=0.22$, p=.64], nor for the total after 24 hours after testing [F $(1,48)=0.00$, p=.99].

Correlational Analyses.

In addition to the main analyses three sets of correlations were carried out: one that assessed the association between the number of cigarettes smoked and the

RWPRT, a second set that assessed the association between the how long the person had smoked and the RWPRT, and a third set that assessed the association between the lifetime usage of cigarettes and the RWPRT, across all current smokers from the study. The purpose of these correlational analyses was to observe whether the number of cigarettes smoked, how long the person had been smoking and lifetime cigarette use in the current smokers was associated with performance on the RWPRT. A set of Pearson Product Moment correlations revealed; no significant correlation between the number of cigarettes used per week and scores on the RWPRT ($r(60)=-0.007$, $p=.95$), nor between the length of smoking and scores on the RWPRT ($r(60)=0.07$, $p=.56$), nor between lifetime usage of cigarettes and scores on the RWPRT ($r(60)=-0.06$, $p=.64$).

7.4 Discussion

Study 6 was designed to observe whether any difference between social (binge) smokers and regular daily smokers would be observed on a real-world prospective remembering task (RWPRT). Age, the number of cigarettes used per week and length of smoking in years, the use of alcohol, cannabis and ecstasy across the week, other drug use, levels of anxiety and depression, and pre-morbid IQ, were measured and statistically controlled for in the study. The findings revealed no significant differences between social and regular smokers on the scores of the RWPRT total, scores before and after the delay, nor on the scores for the items recalled 24 hours after the test. In addition, the correlational analyses suggested that the number of cigarettes used per week, the length of time one has smoked, and the overall lifetime usage was not related to scores on the RWPRT. Again this finding does not provide

support for dose-related PM deficits in smoking. The implications of these findings are considered in more depth in the general Discussion section. As with Study 5, since both groups were smokers, a task demand hypothesis or elevated CO levels theory is not appropriate for the present study.

Taken together the findings from Studies 5 and 6 provide converging evidence that specific patterns of smoking (in the present thesis social (binge) and regular (daily) smoking patterns) do not produce any differential effects upon prospective memory. Rather it appears that it is smoking *per se* is damaging PM. As considered in the previous study, some current research suggests that the notion of social smoking is seen as a growing problem within society, particularly within younger populations, who often drink alcohol alongside smoking, therefore increasing the potential risk to their health and well being (Moran, Wechsler & Rigotti, 2009). The findings from this study and from Study 5 do not support this contention, since in both studies no significant differences between social and regular smokers were found. This does not exclude the possibility that social or binge smoking has a more adverse affect upon heath, but it appears that this does not extend to everyday cognition – PM in the present thesis. Although the RWPRT was deemed to have face validity and demonstrated good reliability, concurrent validity could not be established due to the fact that the use of self-reported PM had ceased, therefore the lack of concurrent validity suggests caution when interpreting the findings.

However this is a new area of research in the field and requires more extensive research before any firm conclusions can be reached. In addition there were a

number of limitations in studies 5 and 6 that should be considered. For example, the average number of cigarettes smoked in the so-called social or binge smoking group was relatively small (18 in Study 5 and 21 in Study 6) which is below the 20-30 per session quoted by Spiro (2003). It is therefore feasible that the smokers tested in Studies 5 and 6 were in fact quite moderate in their use of cigarettes within a social setting (2 – 3 times per week in Studies 5 and 6). Future research might wish to look at higher levels of cigarette use within the social smoker groups. Finally, although smoking has been on the decrease in adults (see e.g. R.C. of P., 2002), it appears to be on the increase in young teenagers (e.g. Amos & Bancroft, 2006), which begs the question whether social or binge smoking is on the increase in this age group and what impact this may have upon their developing systems, including memory systems?

7.5 Chapter Summary

Study 6 was designed to assess there were any difference between social (binge) smokers and regular daily smokers on a real-world prospective remembering task (RWPRT). After controlling for non-memory covariates, it was found that there were no significant differences between the two groups of smokers on the scores of the RWPRT total, scores before and after the delay, nor on the scores for the items recalled 24 hours after the test. Taken together with the finding from Study 5 which observed no difference between social and regular daily smokers on a laboratory-based PRVP task, it was concluded that a particular pattern of smoking does not produce any differential effects on PM performance, but rather it is smoking *per se* that damages PM.

Chapter 8

General Discussion and Conclusions

8.1 Smoking and Cognition

The effects of nicotine and smoking on human cognitive performance have been found to be very mixed. For example some studies have found improvement in cognitive function and memory (Provost & Woodward, 1991; Rusted et al., 1998; Swan & Lessov-Schlaggar, 2007), some have found no change or mixed effects (Roth et al., 1992; Whittington & Huppert, 1997; Parrott and Garnham, 1998; Evans and Drobes, 2008) and other studies showing impairments (Spilich et al., 1992; Ernst et al., 2001; Hill et al., 2003; Fried et al., 2006; Sabia, et al., 2008). However, these studies have primarily focussed on retrospective memory, with little attention being paid to everyday memory, of which prospective memory (PM) is a good example. PM is crucial to independent living (e.g. Kliegel, McDaniel, & Einstein, 2008) and failures in PM can have an adverse effect upon one's social, occupational and personal life.

It is clear from the three studies outlined in the introduction (see section 1.3) to this thesis that the impact of nicotine ingestion upon PM is mixed. Rusted et al., (2005) found evidence that nicotine enhanced PM across a number of conditions, whereas two later studies (Rusted & Trawley, 2006; Marchant et al., 2008) provided evidence that although nicotine appears to enhance PM under relatively simple task conditions, when more demanding tasks are included (e.g. where working memory is taxed), nicotine does not appear to be an enhancer for PM. It should be noted that the

present thesis is concerned with smoking *per se* and not nicotine ingestion and therefore the literature on smoking and PM is reviewed next.

In the first published study relating to PM and smoking, Heffernan et al., (2005) examined self-ratings of long-term PM - measured by the Prospective Memory Questionnaire (PMQ) and everyday memory (EM) measured by the Everyday Memory Questionnaire (EMQ). After statistically controlling for other drug use and strategy use, smokers reported a greater number of long-term PM errors and reported more errors on the EMQ, than did non-smokers. In addition, heavy smokers reported more lapses than light smokers in their long-term PM, suggesting a dose-dependent impact upon long-term PM performance. These findings were taken as suggesting that there are selective memory deficits associated with smoking and that long-term PM deficits should be added to the growing list of memory problems associated with smoking.

More recently, Rash (2007) compared smokers who were deprived of smoking with non-deprived smokers and non-smokers on a series of lexical decision tasks within which PM targets were shown and the participants had to respond by pressing a key on the keypad whenever they recognised the symbol. The results revealed that non-deprived smokers showed the lowest levels of PM performance across the event-based and time-based PM measures, followed by the deprived smokers, with the non-smokers producing the highest level of performance on the PM tasks. The author concluded that PM performance was significantly impaired by smoking. From these studies both Heffernan et al., (2005) and Rash (2007) have demonstrated consistent

PM decrements associated with persistent smoking *per se*, both on self-reported PM and in objective laboratory-based conditions, when compared with non-smoking controls. Although both Heffernan et al., and Rash represented a good starting point in the literature it should be re-iterated that they suffer from severe limitations. The Heffernan et al., study was based wholly on self-reported PM, these have been heavily criticised earlier in the present thesis and may not be understood as being reliable indicators of PM performance. Rash used test paradigms that were simple key pressing techniques to a target item that appeared in an LDT.

It is argued here that the present series of studies, whilst incorporating self-reports of PM used in previous research, extended the research focus to include much more complex and cognitively demanding objective PM measures than used in other research. Previous researchers have predominantly used relatively simple PM tasks (e.g. Rusted & Trawley, 2006; Rash, 2007) where simple key-pressing activity is associated with seeing a word or letter that appeared on a computer screen or responding with a key press after a short period of time has elapsed. In contrast, the objective measures used in the current thesis can be seen as more cognitively demanding. The PRVP tasks used required the participant to memorise a series of location-action combinations, combined with ongoing monitoring of the events, then responding to the cues in the environment and recalling the action-location combinations, all of which make these highly demanding tasks. Similarly, in the CAMPROMPT the participant had to remember multiple PM tasks, including requiring the participant to remember the locations of several items to be recalled at the end of the task, remembering to initiate time and event based items during the

procedure, and recalling a further item after a 24 hour delay. Again this high PM load constitutes a more cognitively demanding task than that used in previous research. Finally, the real-world PM tasks used in the present thesis were similar in make-up to the video-based tasks, except they were based in real world scenarios that have the added complexity of being subject to potential distractions and interruptions.

In the current series of studies, the association between chronic smoking and PM was investigated using self-report and objective measures of PM. The use of objective measures of PM is important due to the range of biases self-reported PM might be subject to, such as under- or over-estimations in ones memory abilities. Self-reported memory problems are also affected by ones mood, with low mood states believed to be associated with increased reports of cognitive deficits, particularly of an everyday nature (e.g. Dalgleish & Cox, 2000). In addition, self-reported memory lapses in other drug-related PM research yielded inconsistent results. For example, Rodgers et al., 2001 reported cannabis related errors on the PMQ whereas Bartholomew et al., (in press) failed to find any such lapses in cannabis users. Similar inconsistencies are found when studying self-reported memory lapses associated with excessive alcohol use (see e.g. Heffernan, 2008 for a review). Therefore the use of self-reports as a main source of detecting memory disorders should be used cautiously in future research.

Previous smokers were also observed to see whether smoking cessation had any impact upon PM performance in terms of some recovery of function in PM. In addition, a comparison of social smokers (binge smokers) and regular smokers was

also made (Studies 5 and 6) to observe whether the pattern of smoking produces different effects upon PM performance. Co-variation was used to control for other factors believed to be related to PM, for example, other drug use, mood and IQ.

8.2   Summary of Studies 1 – 6

8.2.1. Study 1

Study 1 attempted to replicate the self-reported long-term PM deficit found by Heffernan et al., (2005) and to observe if such deficits extended to an objective measure utilising the PRVP. It also explored whether a cessation from smoking resulted in any improvement in PM. Smokers, non-smokers and previous smokers were compared on the PRVP, the PMQ, and a drug-use questionnaire. The results revealed a mixed pattern on the self-report of PM. For LTPM previous smokers reported significantly fewer PM lapses than smokers and non-smokers, with no difference between the latter two groups. No between- group differences occurred with regards STPM lapses. For the ICPM sub-scale previous smokers reported significantly fewer PM lapses than smokers and non-smokers, with no difference between the latter two groups. The finding from the LTPM lapses is not consistent with Heffernan et al., 2005 who found that smokers reported more lapses than non-smokers. The fact that previous smokers reported fewer lapses on their long-term PM and their internally-cued PM suggests that they perceive their everyday PM to be more effective than when compared with the other two groups and is consistent with the notion that there may be improvements upon smoking cessation. The lack of any difference between the smokers, non-smokers and previous smokers on the STPM

suggests that short-term PM is not perceived to be adversely affected by prolonged smoking.

With regards the objective measure, non-smokers recalled more items than smokers, with no difference between the previous group and non-smokers, nor between the previous group and smokers. The previous group appeared to fall between the two other groups in terms of their PRVP performance. These findings were observed after controlling for non-memory covariates. The difference between smokers and non smokers on the PRVP supports the notion that there are PM deficits associated with prolonged smoking. With the previous group falling between the other two groups on the PRVP there is a suggestion that there is some recovery of function in this group, but not sufficient to bring them up to non-smoking levels of performance.

8.2.2. Study 2

Study 2 attempted to verify the findings from Study 1 using an improved method. Smokers, non-smokers and previous smokers were compared on the CAMPROMPT, the PRMQ, the HADS, the NART and a drug-use questionnaire. The findings revealed a number of things. The pattern of self-reported memory lapses found in this study revealed no significant differences between smokers, non-smokers and previous smokers on any of the subscales of the self-report PM measure. This was not consistent with the findings from Study 1 and failed to provide support for the long-term PM self-reported deficits found by Heffernan et al., 2005. The overall results of the CAMPROMPT revealed non-smokers and previous

smokers both performed significantly better on the CAMPROMPT than smokers, with no significant difference between the non-smokers and the previous group. These findings were observed after controlling for non-memory covariates, including the additions of mood and pre-morbid IQ. The findings from the objective measure were consistent with those found in the previous study and add further support of the notion that prolonged smoking is associated with PM deficits. The fact that previous users performed as well as non-smokers on the CAMPROMPT suggests that there is some recovery of function of PM upon smoking cessation.

8.2.3. Study 3

Study 3 attempted to assess whether PM deficits associated with smoking extended to real-world PM paradigm. Smokers, non-smokers and previous smokers were compared on the RWPMT, the PRMQ, the HADS, the NART and a drug-use questionnaire. The findings revealed a number of things. The findings of the present study revealed no significant differences between smokers, non-smokers and previous smokers on any of the subscales of the self-report PM measure. The results did reveal significant between-group differences on the RWPMT – which demonstrated that both non-smokers and previous smokers performed significantly better on the RWPMT task than smokers, with no significant differences between non-smokers and previous smokers. These findings were observed after controlling for non-memory covariates. The findings from this third study reinforce the notion that prolonged smoking is associated with lower PM performance and extends this finding to a real-world PM task. Again, the fact that the previous smokers performed

at the same level as the non-smokers on the RWPMT reinforces the notion that abstinence from smoking leads to some recovery of function in PM.

8.2.4. Study 4.

Study 4 explored the possibility that a confound of smoking withdrawal may have accounted for the poorer performance in smokers on the objective PM tasks, given the time that had elapsed between some of the smoking participants having last had a cigarette and the testing phase. This may have meant that some of the smokers may have been in a state of smoking withdrawal. This possibility was tested by focusing upon current smokers only and comparing two orders of presentation: Condition 1 where the self-reports, were presented first, followed by the objective PM task (the PRVP) thus introducing a gap of around 20 minutes, and Condition 2 where the objective PM task was presented first, followed by the self-reports (thus not having a gap between presenting the to-be-recalled PM items and recall). This would allow for a comparison of state of withdrawal by counterbalancing the presentation of the objective measure of PM. All smokers were required to smoke immediately before the start of any test. The findings of the present study revealed no significant differences between Condition 1 and Condition 2 on the PRVP scores - having a delay of approximately 20 minutes between having the last cigarette and carrying out an objective PM task did not have an adverse impact upon performance due to being in a state of withdrawal. These findings were observed after controlling for non-memory covariates. Thus it is concluded that the findings from Studies 1 and 3 were unlikely to be the result of withdrawal effects.

8.2.5. Study 5

This study explored a very recent focus point (yet still under-researched) in relation to whether different patterns of smoking produce differential effects upon PM. Social Smokers (those who smoked between 1 - 3 social occasions per week and smoked up to a maximum of 30 cigarettes within the week), were compared with Regular Daily Smokers (those who smoked in excess of 30 cigarettes within a week, but across each day). These two groups were compared on the PRVP, the HADS, the NART, a memory strategy scale, and a drug-use questionnaire. The findings revealed a number of things. The results of Study 5 revealed no significant difference between Regular Daily Smokers and Social Smokers on the scores of the PRVP. These findings were observed after controlling for non-memory covariates. It was concluded that the pattern of smoking in terms of whether one is a Regular (daily) or Social (binge) smoker does not have a differential effect on PM performance. Social or binge smoking is, therefore, just as damaging to PM than regular daily smoking.

8.2.6. Study 6

Study 6 repeated the design from the previous study, but extended the research focus to observe any potential differences between Social Smokers and Daily Regular Smokers on a Real-World Prospective Remembering Task (RWPRT) as the objective measure of PM functioning. These two groups were compared on the RWPRT, the HADS, the NART and a drug-use questionnaire. The results of the study revealed no significant difference between Regular Daily Smokers and Social Smokers on the scores of the RWPRT. These findings were observed after controlling for non-memory covariates. As in Study 5, it was concluded that it is

smoking *per se* that damages PM and not any particular pattern of smoking. The findings from Studies 5 and 6 are not consistent with the notion that social/binge smoking could be more dangerous than regular daily smoking in terms of cognitive processes such as PM, rather it is smoking *per se* that appears to have a damaging effect upon PM.

8.3   Conclusions drawn from Studies 1 – 6 and their Implications

8.3.1. Findings Self-reports of PM

The findings from Study 1 did not find any differences in LTPM lapses in smokers when compared with non-smokers using the PMQ self-report measure. Therefore the findings from study 1 failed to support the previous findings from Heffernan et al., 2005 (who found more reported LTPM lapses in smokers when compared with non-smokers). The fact that the previous smokers reported significantly less PM errors than smokers and non-smokers on the LTPM and ICPM sub-scales of the PMQ is consistent with the notion that smoking cessation leads to improvements (at least perceived) in everyday PM functioning. The lack of any between group differences on the STPM implies that prolonged smoking/non-smoking/smoking cessation has no perceived impact upon everyday short-term PM. Studies 2 and 3 used a different self-report measure (in the form of the PRMQ (Crawford et al., 2003)) which also incorporates long-term and short-term PM, and again failed to support the LTPM deficits observed in Heffernan et al. Indeed, the self-reported lapses in Studies 2 and 3 provided very mixed and non-systematic findings between smokers, non-smokers and the previous smokers group. As noted earlier in the thesis, this lack of consistency has also been found with studies into

other drug research. For example, the finding by Rodgers et al., (2001) that cannabis users reported more short-term and internally-cued deficits in PM when compared with non-users was not replicated by more recent research using the same self-report questionnaire in the form of the PMQ (Bartholomew et al., in press). Self-reports of PM have their strengths. For example, they enable one to ask questions about a whole range of aspects of everyday PM; they are easy to administer and complete; and they can provide a quantitative measurement of self-reported PM forgetting. However, given the lack of consistency in using them for drug-related research and their general limitations (see introduction to this thesis), it is concluded that self-reports of PM cannot be relied upon alone to draw firm conclusions about whether PM deficits are associated with particular substance misuse. This provides an important note of caution for future research on the impact of recreational drug use has upon everyday cognition.

On the relative merits of the two self-report measures used in the present thesis, namely the PMQ and the PRMQ, although the PMQ is an established self-report of PM (see Hannon et al., 1995) the authors themselves acknowledged that the PMQ did not correlate well with a number of other objective measures of PM. For example, the correlation between the long-term PM subscale was only weakly correlated with an actual PM task which required the participant to return a number of questionnaires at a later time (r(141) =-.06, p=ns), nor correlated with the task that required the participant to place their name and the current date on the questionnaire before returning them (r(141) =.01, p=ns), neither was the total PM score from the PMQ correlated with these two long-term examples of PM (r(141) =.01, p=ns and

r(141) =.07, p=ns) respectively. As stated earlier in the thesis, recent work by Buchanan et al., (2005) has questioned its validity by demonstrating that not all the sub-scales load onto the construct known as PM. The Prospective and Retrospective Memory Questionnaire (PRMQ: Crawford et al., 2003) is an alternative self-report that measures long and short term PM and has shown construct validity and good reliability (.83 for the PM component and .92 for the retrospective memory component). It is therefore concluded that the PRMQ is preferable to using the PMQ as a self-report measure of PM. Although self-reports are useful ways of gauging one's PM abilities, it is recommended here that they be used alongside objective measures of PM.

8.3.2. Findings from the objective PM measures

Across all of the three objective PM measures (utilised in Studies 1 – 3) smokers performed worse than non-smokers. Previous smokers tended either to fall between the other two groups in terms of their PM performance (as in Study 1) or were on an equal par in terms of PM performance with the non-smokers (in Studies 2 and 3). Study 4 suggested that these deficits were not attributable to smokers being in a state of smoking withdrawal. Taken together, these findings provide convergent evidence that prolonged smoking is associated with lowered performance on a range of objective PM tasks (specifically on the PRVP, the CAMPROMPT, and on the RWPMT), which are evident beyond any self-reported lapses in PM. The overall findings from previous users suggest that there may be some recovery of PM function when a period of cessation of smoking has occurred, but the degree to which recovery is evident is variable. The findings support previous research that has found

evidence of memory deficits associated with prolonged smoking. For example, Jacobson et al, 2005 found that current smokers showed impaired working memory performance using the 1- and 2- N-back working memory procedure, but not on simple word recall where the participants were expected to recall as many words as possible both immediately after presentation and following a 25 minute delay. The findings are also consistent with what little is known about the damaging impact of prolonged smoking and PM (Heffernan et al., 2005) albeit on objectives measures in the present thesis. The deficits on the objective measures of PM found here are also supportive of the recent finding by Rash (2007) who also found deficits on a simple PM laboratory-based paradigm associated with current smoking.

In addition, the finding from Study 3 in the present thesis has demonstrated that the impaired PM performance in smokers extends to a real world setting, which is an important development that has been suggested by current PM researchers (McDaniel & Einstein, 2007). The inclusion of real world paradigms are important because if smokers do experience significant deficits in their PM functioning, then the observation that these deficits extend to the real world may have most relevance to the smokers themselves and how they perform in their everyday setting. This latter point could be used to educate those who continue to smoke about the everyday dangers of prolonged smoking. It is also clear from the present findings that the use of objective PM measures provides more consistent responses than the utilisation of self-reported PM questionnaires. As stated throughout the thesis, the findings from the objective measures of PM need to be interpreted with caution. For example, the performance on the self-reports of PM do not support these trends (i.e. that smokers

189

show impaired PM performance), a clear conclusion of this kind (i.e. smoking damages PM) should not be concluded from 3 single findings (the findings from the PRVP, CAMPROMT, and RWPMT) and further findings are needed before any firm conclusion can be reached. In addition one should be aware that an association does not infer causality.

8.3.3. The findings from the previous smokers

An additional finding from the present thesis (Studies $1-3$) was the observation that previous smokers performed better than smokers on all 3 objective measures of PM, and in some cases performed to the same high level as non-smokers. This suggests that there may be some recovery of cognitive function, in the present context of PM performance, following a period of smoking cessation, but this may not always be to non-smoking levels (since previous smokers did not always reach non-smoking levels of PM performance). These findings may have important implications on future smoking cessation campaigns and educational programmes for people of all ages. For example, the suggestion that smoking cessation can lead to improvement in function could be used in smoking cessation campaigns, and this information could be used to focus on young people who smoke, whose brains are still developing (e.g. Fried, Watkinson & Gray, 2006).

Cessation of recreational drug use leading to some recovery of PM function has also been found in cannabis research. For example, Bartholomew and Holroyd (2008) used the PRVP (adapted from Forster, 2003) to uncover PM deficits in regular cannabis users when compared to non-users. Within this study the authors

also provided evidence that previous users showed some recovery in function of PM performance on the PRVP, demonstrating that they performed at non-users levels on this task. They concluded that cessation of use of cannabis led to recovery in function in PM. In another recent study Pitel et al., (2008), found that alcoholic patients who abstained from alcohol for 6 months or more showed a restoration of some working memory function (specifically executive processes such as planning) that was similar to those controls who were not alcohol-dependent or addicted. Thus, there is good evidence that abstinence from a range of drugs leads to some degree of restoration of memory function, which is demonstrated in the current thesis for smoking cessation. In terms of the present thesis, recovery of PM function could be the result of a reduction in CO diminishing the oxygen carrying capacity of the blood which can deprive the brain of oxygen, therefore leading to improved cognitive function in terms of PM performance. It should be noted that the literature on recovery of memory function from other drug use was included here merely to establish that recovery following cessation of drug use is evident for a range of substances used. The explanations for recovery in memory function across different drugs may be varied and that the CO explanation discussed here relates purely to smoking cessation.

8.3.4 Putative explanations of the findings.

With regards to offering an explanation for the findings from the thesis, particularly from Studies 1 – 3 where smokers, non-smokers and previous smokers were incorporated, there are at least two possible explanations. One relates to the task

demands involved in the various PM tasks and the second involves a consideration of putative carbon monoxide induced memory decline.

Previous research suggests that smoking nicotine can have an enhancing effect of simple memory recall tasks, such as retrospective word recall (Rusted et al., 1998; Warburton et al., 2000). Similar benefits have been found on PM tasks, for example, PM enhancement is found under relatively simple task conditions (e.g. Rusted & Trawley, 2006; Rash, 2007) where simple key-pressing activity is associated with seeing a word appear on a screen. However, when more demanding tasks are included, for example, where event-based and time-based PM tasks are included in the study, smoking nicotine does not appear to be an enhancer for PM and decrements in PM are observed (e.g. Rash, 2007).

With regards to the current thesis. The findings from Studies 1 – 3 which found that current smokers performed worse on all three objective PM tasks (the PRVP, CAMPROMPT and RWPMT) when compared with non-smokers is explicable in terms of the relatively high task demands involved in all three tasks. With regards to the PRVP test, the memorising of a series of location-action combinations, combined with ongoing monitoring of the events + responding to the cues in the environment + recalling the action-location combinations, all make this a highly demanding task. Similarly, the CAMPROMPT required the participant to memorise a series of items to be recalled at the end of the study, as well as remember and initiate a series of ongoing event-based and time-based actions during a filler task, plus final recall of a series of items at the end of the study and then 24 hours later, make this a high

demand task. The RWPMT was similar to the PRVP except it was within a real-world scenario and therefore represents a high demand task as with the two previous tasks considered.

All three tasks can be seen as highly demanding tasks and therefore the decrements in performance observed in smokers compared with non-smokers across Studies 1 – 3 could be mimicking the findings from previous studies that show smoking nicotine does not benefit memory in high-demand situations. This could be due to the extra resources involved in high-task demands (which involve working memory processes) overriding any nicotine enhancement (as found in previous research such as Rash, 2007). Although the exact psycho-biological explanation of this is not yet understood, previous researchers have suggested that the combination of smoking nicotine and high arousal (induced under high demanding cognitive tasks) may lead to a state of over-arousal that can induce decrements in cognitive performance – a type of 'inverted U' effect of arousal (see e.g. Rash, 2007). The fact that previous smokers fell between the other two groups (smokers and non-smokers) in their performance on the objective PM measures used in Studies 1 – 3 may reflect them fluctuating between gains and losses associated with highly demanding PM tasks in relation to their having stopped smoking. However, the exact nature of the interaction between smoking cessation, arousal and PM performance is far from clear. The self-reports completed in Studies 1 – 3 would not place high demands upon the participant (since they are allowed to recall freely at their own pace and were 'retrospective' in nature) and therefore may not be expected to show

decrements in smokers due to high arousal. Studies 4 – 6 only included smokers and therefore are not subject to the 'arousal-explanation' offered here.

Within the Multi-Process Model of PM (McDaniel & Einstein, 2007) the findings from the objective tasks on all three studies (the PRVP, the CAMPROMPT and the RWPMT) are explicable in terms of the objective PM tasks requiring greater effortful processing that might have a more adverse effect on smokers when compared with non-smokers and previous smokers, leading to reduced PM recall in smokers. Therefore the Multi-Process Model offers a useful PM framework from which one might interpret the current findings from Studies 1 - 3 and should be used in future research as a putative explanation for smoking-related deficits in complex PM tasks.

With regards the third putative explanation. As considered earlier in the thesis, human haemoglobin has a much greater affinity for carbon monoxide (CO) than for oxygen, therefore, inhaling tobacco smoke with a high level of CO diminishes the oxygen carrying capacity of the blood which can deprive the brain of oxygen (Parrott et al, 2004). CO poisoning has been found to impair cognitive function in those who have survived poisoning, resulting in a range of cognitive declines including attentional difficulties and deficits in executive function (Hopkins & Woon, 2006). It is feasible that the decrements in PM performance in smokers found in Studies 1 – 3 is explicable in terms of the smokers having reduced oxygen levels to the brain which results in lowered cognitive function, in this case PM.. This explanation could also explain the improvements observed in previous smokers in

Studies 1 - 3, since the resumption of normal levels of oxygen to the brain may improve the form and function of the brain resulting in improved PM performance. This model is somewhat speculative but does have logical appeal as an explanation for the decrements and improvements observed in the present thesis. This explanation does not explain the very mixed findings associated with the self-reports of PM reported in this thesis.

Studies 5 and 6 focused on the new phenomena in the literature known as social smoking (otherwise known as binge smoking). Both studies revealed no significant differences between social (binge) smokers and regular daily smokers on two objective measures of PM (the PRVP and RWPMT). Taken together the findings from Studies 5 and 6 provided converging evidence that it is not the pattern of smoking that is associated with deficits in PM functioning, rather it may be prolonged smoking *per se*. It would appear that, despite claims that social (binge) smoking may be linked to more damage to one's health and physiology (Spiro, 2003), this does not appear to extend to greater levels of impairment in everyday prospective memory. From the present findings it can be concluded that there is no scientific support for claims by Spiro (2003), however further research needs to be conducted in order to provide firm conclusions in relation to what impact binge smoking might have upon everyday cognition. It should be noted that although no significant differences were observed between social/binge smokers and regular/daily smokers in the present thesis, this was based upon relatively young cohorts. Therefore this pattern of smoking and its impact upon everyday PM should

be observed in a range of age groups (young, middle, old) before any firm conclusions can be drawn.

The findings from the correlational analyses.

In addition to the main analyses, three sets of correlations were carried out in each study: one that assessed the association between the number of cigarettes smoked and the self-reported (only used in Studies $1 - 3$) and the objective measures of PM, a second set that assessed the association between how long the person had smoked and the self-reported reported (only used in Studies $1 - 3$) and the objective measures of PM, and a third set that assessed the association between the lifetime usage of cigarettes and the self-reported reported (only used in Studies $1 - 3$) and the objective measures of PM across all current smokers. The overall findings from the correlations revealed no relationships between any of the PM measures and the number of cigarettes smoked per week across all six studies. Taken together this does not support the notion of any dose-related PM impairments in terms of the amount of cigarettes smoked per week. This is surprising considering that previous research has found a difference between light and heavy smokers (Heffernan et al., 2005) where heavier smokers reported more PM lapses than lighter users and it is also inconsistent with dose-related increases in self-reported PM found for alcohol misuse (Ling et al., 2003). However, there is a need for caution with this interpretation since the number of cigarettes across a week is only a snapshot of their cigarette use and the picture may be different if one calculates the dose across their lifetime period.

However, the length of smoking did correlate with scores on the PRVP (Study 1), the CAMPROMPT (Study 2) and the PRVP in Study 4 in that the longer one had smoked the worse the performance on these three objective measures of PM. Finally, the lifetime usage also correlated with scores on the PRVP (Study 1) and the CAMPROMPT (Study 2) with partial correlations suggesting that it was predominantly the length of time one had smoked that was important in the correlations and not the number of cigarettes smoked per week. These latter findings suggest that something other than the number of cigarettes is accounting for the increased impairments in PM performance; some other cumulative effect appears to be involved – probably the length of time spent smoking. The relationship between length of time spent smoking and lowered performance on the objective PM tasks found here are consistent with previous research that has showed accelerated verbal memory declines (in word recall tasks) and verbal fluency declines in smokers as a function of their number of cigarettes x length of use (Nooyens, van Gelder, & Verschuren, 2008; Sabia et al., 2008), and general cognitive decline (Galanis, et al., 1996). These declines have been linked with increases in accelerated cerebral degeneration, such as brain shrinkage and atrophy (Meyer, et al., 1999), although it should be noted that the precise areas of the brain that might be damaged as a result of this degeneration requires further elucidation.

When it comes to the self-reports of PM from Studies 1 – 3 the picture is very mixed, with some of the studies showing a significant relationship between the length of smoking and the number of errors reported on the LTPM in Study 1 and the lifetime usage and the number of errors reported on the LTPM and ICPM in Study 1,

but the negative correlations for these suggest that the longer one has smoked/greater the lifetime usage the less memory problems they experience, which again goes against the notion of any dose-related PM impairments and previous findings (Heffernan et al., 2005). Given that self-reports may be prone to overestimation/underestimation of one's abilities, it is suggested that the findings from the objective measures may provide a more accurate view of what is happening.

There is a need for some further caution since correlations may reveal relationships between factors they do not allow one to draw any firm causal relationship between the two factors. So although the correlational analyses presented in this thesis have offered some interesting insights, it is suggested that they are not used as the main basis for any conclusions in relation to smoking and PM performance.

8.3.5. General implications of Thesis

PM is crucial for independent, healthy and safe living and problems in this area of memory may have serious implications on everyday life. People often feel it a burden when their normal human existence has to depend upon others for assistance in daily living. Older people particularly are often faced with the trauma of having to rely upon other people to complete what should be their normal daily tasks. Similarly, in order to stay healthy after illness, people have to remember to obtain prescriptions from the doctor, remember to go to the chemist to have the prescription approved and then to take the medicine at the prescribed times. In addition, an individual's safety is important, such as remembering to close the door at night, to

take care crossing the road, using the time-honoured procedures for both. Therefore maintaining an intact PM is critical for maintaining a healthy, safe, and happy, style of living. It would appear that prolonged smoking is associated with lowered performance in the systems underpinning everyday PM and thereby affect the whole spectrum of daily living.

Although the studies in this thesis point to an association between lower PM performance associated with prolonged smoking, due to facilities being unavailable (such as brain imaging techniques) the current research has not identified the potential site of damage underpinning PM. Brain imaging studies could highlight the involvement of areas of the brain such as the prefrontal cortex, hippocampus and the thalamus, in PM processes. Burgess, Quayle and Frith, (2001) and Simons et al (2006) identified these areas when investigating the effects of various PM tasks on the brain using fMRI processes. Both studies found evidence suggesting that lateral areas of the prefrontal cortex appear to be responsible for the maintenance and or retrieval of the stored PM intention and also showed greater activation when maintaining the intention in memory during an ongoing task. Therefore future research should utilise imaging technology alongside some of the objective PM tasks used here in order to pinpoint the area of potential damage underpinning the deficits found in the smoking populations used in the present thesis. In particular, the potential damage to the frontal and pre-frontal cortices implicated in planning and execution in PM. The inclusion of a smoking cessation group could also be useful in order to establish whether there is some recovery of function in PM and related processes using such brain imaging techniques.

The results from the thesis also suggest that the use of cognitive theory could be used within a clinical context to uncover new insights into the known links between drug use and cognition. In the present thesis this has proven effective in using a PM framework to study everyday memory deficits in smokers. The use of cognitive theory to drive research into drug use and their impact upon psychological functioning could be utilised to study other forms of drug misuse, such as the use of prescription medication (for example, anti-depressant medication), and so on. The findings from the current series of studies reinforce the use of PM as a framework from which a range of phenomena can be studied, including neuropsychological deficits, drug misuse, ageing, and applied aspects of everyday functioning. This can be achieved by using cognitive theory, such as our understanding of PM, in an applied setting. For example, changes in PM performance during a period of abstinence, or a period of treatment for drug use, would enable the researcher or clinician to plot recovery function in PM processes in order to assess whether the intervention is effective.

More generally, the findings of the present series of studies may have educational and clinical relevance. For example, the evidence that smoking damages everyday memory can be used in educational anti-smoking campaigns that can benefit all people who continue to smoke by warning them about the damaging cognitive consequences of continued smoking. This may be more pertinent to adolescents in schools and the young people within higher educational establishments who also persist in smoking. An example of the applied nature of

these findings comes in the form of using such information to educate clinicians (i.e. Doctors, Nurses), about the everyday cognitive damage caused by prolonged smoking. The Royal College of Physicians have consistently warned the medical profession about the dangers of smoking and they too have shown particular concern about the smoking practices of the teenage population (see e.g. R.C. of P., 2002).

Consequently, now is the time to use this information from the studies in prevention campaigns and to enhance the communication to medical and nursing staff about the everyday cognitive difficulties teenagers with smoking problems face, in order to equip them with more knowledge and skills in their professional practice. Indeed the DHSS (1999) and McGillion et al, (2000) have highlighted the fact that medical and nursing staff are hindered in their attitude and subsequently their responses towards patients presenting them with drug-related problems. This, they feel, is primarily due to their lack of knowledge about the difficulties arising from patients who abuse drugs, including persistent smoking. The findings from the present thesis could be used to educate medical and nursing staff about the more general everyday cognitive deficits that smokers' experience, beyond the health related difficulties presented to staff. For example, intervention programmes might wish to provide training in the form of enhanced memory strategies to offset some of the everyday memory problems experienced by particular types of drug users, including smokers. The National Treatment Agency for Substance Misuse published a framework for guidance to nursing staff and health care professionals on improving their knowledge about drug misuse, the problems faced by patients as a result of their drug abuses, as well as the development of an effective management system in

England specifically dealing with the direct and indirect effect of drug misuse in patients (National Treatment Agency for Substance Abuse, 2002).

8.4 Methodological Limitations

Although the use of self-reports of PM has a number of merits, such as enabling one to ask a multitude of questions about everyday remembering, their administrative ease, and so on, they do have their drawbacks when compared with objective measures. The relative merits of self-reports such as the PMQ and PRMQ have been discussed earlier in the thesis (see page 187) so these will not be laboured here. However, one major difficulty that might arise from the use of self-reports of memory might be the emergence of a type of *memory paradox* – in which one asks a person suspected of having a poor memory about their memory! One could overcome this by using objective measures of PM alongside self-reports, or one could gauge proxy ratings of self-reported PM which would involve administering a test such as the PMQ or PRMQ to a close relative or partner of the drug-user under study so that the drug-users everyday PM could be verified.

Although other drug use was statistically controlled for in all 6 studies in the present series, it is still possible that there was a complex interaction of participants taking part who had previously taken a combination of drugs (such as alcohol) which when interacting with their smoking habit may have contributed to the PM deficits observed in the current studies. Future research should ideally access large populations of smokers, previous users and non-smokers who, ideally, had refrained from taking any other form of drugs for a prescribed period of time. This would

enable the researcher to screen out other drug use, or, in terms of alcohol use, ensure that its level of use was below that believed to be damaging to ones' memory (see Heffernan, 2008 for a discussion on alcohol and PM). It should be noted that alcohol and other drug use was controlled for statistically in the present series of studies. Using self-reported drug use introduces the possibility that some individuals over-estimated or under-rated their own drug use. Introducing some form daily screening for the type of drug use across a given period of time would provide more accurate drug use characteristics, but may not tell you exactly how much of the substance was used.

One major concern with the present thesis was the issue of validity of some of the tests used. Although all 6 studies were deemed to have face validity and showed good split-half reliability, it should be noted that in Studies 3 and 6 concurrent validity was either not established (Study 3) or was not possible due to the lack of a second measure of PM (Study 6). Studies 1 and 2 showed good concurrent validity between the two PM tasks and the concurrent validity of the PRVP used in Studies 4 and 5 was already established by the original author (Jardine, 2002). However, in studies 3 and 6 concurrent validity was not established and therefore these tasks are brought into question in terms of the degree to which the real-world PM tasks reflect everyday PM processes. Although the utilisation of real-world PM tasks is welcomed within the field (McDaniel & Einstein, 2007) and allows one to study PM within a more naturalistic setting, they bring with them a much changing dynamic background. For example, in a real-world paradigm one experiences delays, distractions and interruptions that can be controlled for within a laboratory situation

(such as that found with the studies that have used PRVP methods and the CAMPROMPT). The real-world PM paradigms used here may have been subject to such fluctuations which may have impacted upon some individuals more than others in terms of their performance. Such difficulties with validity of real-world paradigms suggests that cautious interpretation of the findings from such studies is required - given that the objective tests in these studies have not been proven to be conclusively valid measures of PM. Future research should validate real-world measures of PM alongside other measures, such as the PRVP and CAMPROMPT. Indeed, future research should opt for a battery of objective PM tasks in order to assess concurrent validity of such tasks.

Another area of concern is the categories used in the present series of studies. In the present thesis the grouping categories were simply smokers: those who were currently smoking (regardless of the number of cigarettes used per week); previous smokers: those who had stopped smoking for at least 6 months; and non-smokers: those who had never smoked. Previous studies have used similar categories to those used in the present thesis (see e.g. Mitchell, 1999; Mendrek et al, 2006; Rusted & Trawley, 2006; Rash, 2007). However, since the current thesis had smokers included in some of the studies as low as 2 cigarettes per week, and much of the research cited above operated upon a daily dose of at least 10 cigarettes per day, it is feasible that some of the current smokers were considered to be very light smokers and that this have could have masked some dose-related deficits in PM. Although it is interesting to note that despite having some very low cigarette users in studies $1 - 3$ significant smoking-related deficits on the objective measures of PM were still observed,

suggesting it is smoking per se that might impact negatively upon PM. Future research should either control for the minimum number of cigarettes used by the smoking group (e.g. a minimum of about 10 per day in line with the other research outlined above) or explore dose-related PM deficits using different dose-groups in terms of the number of cigarettes smoked per week.

A further limitation which future researchers might also wish to consider is whether different withdrawal periods in smokers have a differential impact upon PM performance, a limitation noted in the discussion section of Study 4. Withdrawal periods of minutes, hours or even days could be manipulated in order to elucidate the nature of smoking withdrawal and its impact upon PM performance in smoking populations.

Studies 5 and 6 have produced interesting results that support the notion that smoking *per se* has a damaging effect upon everyday PM, regardless of whether one is a Social or a Regular smoker. However, the notion of binge smoking can be criticised in terms of what constitutes binge smoking (in the current thesis defined as those individuals who smoked 30 cigarettes or less within 1 - 3 occasions within a given week). Specifically, it is not clear from the literature (which is understandable considering it is an area yet to be researched in any depth) what constitutes a binge session − when does smoking a small quantity (e.g. 1, 2, 3, cigarettes in a given session) become a problem binge smoking condition (when compared to, say, 30 cigarettes in one session)? There is a need for clearer operational definition of what is meant by social or binge smoking.

Although the conclusion reached from Studies 5 and 6 was that it appears to be smoking per se that has a deleterious impact upon PM, such a conclusion needs to be interpreted with caution. Since neither Study 5 nor Study 6 included non-smoking controls, it is uncertain whether the non-significant differences between regular and binge smokers is the result of there being no genuine difference in PM as a result of differential smoking patterns, or whether it is some other artefact of the design. Had non-smoking controls been included then it would have been possible to replicate the deficits in smokers per se when compared with non-smokers (as in Studies 1 – 3). Therefore future research should include non-smoking controls in studies that compare patterns of smoking and their putative differential impact upon PM. This concern particularly relates to Study 6 which, in addition to not having a non-smoking control group, did not have a second PM measure against which a validity check could have been carried out on the RWPRT task. It is feasible that the RWPRT (unlike the PRVP in Study 5 which had an already established valid and reliable PRVP test: Jardine, 2002) lacked validity and therefore the lack of any significant differences between regular and binge smokers may have been due to some artefact unrelated to PM. Future research should ensure validity and reliability of such tests before testing begins.

There may be an issue in terms of strength of the cigarettes smoked. In the present study the strength of cigarettes used was not controlled for and future research should control for this by gauging the strength of cigarettes used across participants and controlling for this within the design or statistical analysis (e.g. by comparing different strengths across conditions or by using statistical co-variation).

Apart from Study 1 the populations used as participants in the studies have been student-based. The use of university student populations may well provide further problems in terms of the generality of the findings. Students at university are primarily from advantaged backgrounds (Powdthatres & Vignoles, 2008), with the more disadvantaged and poorer young people are more likely to be precluded from going to university. Therefore, a wider sample of university and non-university participants should be included to improve the generalisation of the findings to the wider population of young adults.

The mood questionnaire used in Studies 2-6 comprised the Hospital Anxiety and Depression Scale (HADS) questionnaire. This questionnaire is a valid and reliable tool that is used in psychological testing. It is however a simple one-page self-report questionnaire that is based on only a handful of questions. Perhaps the inclusion of other better techniques for measuring anxiety and, particularly, depression, could be used (i.e. a clinical interview). The clinical interview might improve the quality and accuracy of the answers provided (e.g. the interviewer could follow up questions with more in-depth discussions). This technique could not be applied in the present thesis because the author had not received any training in this type of interviewing technique.

Although the use of the NART was based on the fact that it is a widely used measure of estimating pre-morbid ability in neuropsychological and clinical research (see e.g. Crawford et al., 2001), it is easy to administer, and is user friendly, but it does have its drawbacks. For example, some of words used in the NART represent

older words that may not be popular in current language usage, particularly with younger people. This may introduce a bias when comparing different age groups and needs to be accounted for when analysing the data. In addition, although the NART is a useful measure of prior learning there is some debate as to whether it is the most reliable index of current IQ (Crawford et al., 2001). Therefore future research should implement a battery of IQ tests to ensure no differences between the groups under study on prior and current IQ.

It is feasible that any group in any of the studies included in the current thesis may have had a generally poor memory to begin with, regardless of the task imposed. Therefore, between-group differences in PM performance may have been influenced by individual variations in memory ability to begin with. There are two possible ways that this could have been controlled for in the present thesis. One would have been to test all the participants from each study on a series of baseline memory measures, such as a series of retrospective memory tasks, and then select participants from each of the categories (smokers, non-smokers, previous smokers) who have been matched on their retrospective memory abilities and recruit these participants to the groups within each study. Thus, all participants across the different groups would be matched on measures of general memory ability and any between-group difference on PM could not be attributable to general memory ability. A second method would be to truly randomly allocate participants from the whole of the smoking, non-smoking and previous smoking populations within society to each group within each study. This would therefore ensure the equal distribution of memory abilities across the study groups. However, this latter procedure is rarely

attained in research, particularly given the fact that most research uses opportunity sampling as a method for recruiting participants.

A further limitation of the present thesis is that although in Studies 1 - 3 it was concluded that persistent smoking impaired PM, it was not possible to identify where the damage was taking place. The application of brain imaging techniques could go some way to elucidate this issue (as discussed in the following section).

Stereotyped threat occurs when individuals who are labelled as intellectually inferior go on to perform badly on cognitive tests designed to test their intellect, thus creating a type of self-fulfilling prophecy in that they act in accordance with that stereotype (as raised by Cole & Michailidou, 2006). For example, if one labels an ecstasy user as having poor memory, then tests that person on a memory battery, then he/she may well perform below their par in accordance with that label. Since all the participants in the current thesis were provided with neutral Participant Information details (i.e. no mention of smoking being linked to memory deficits), this was not a confound in the present series of studies. However, future research could avoid the potential for this effect by ensuring that their participant information is neutral.

8.5 Future Research

Future research could extend the focus by looking at dose related social smokers (i.e. whether a person smokes 5, 15, 20, or more in a given session) in order to test the concept that the more one smokes in a binge session may have more adverse

effects upon their health and thus their psychological states. In addition, the strength of the tobacco used in the cigarettes could be compared to observe whether increasing strength has a greater detrimental effect upon cognition and PM in particular. Also, the pattern of smoking behaviour may differ from individual to individual, with some individuals finishing whole cigarettes (and therefore ingesting more of the nicotine and accompanying chemicals) than those who finish, say, only half a cigarette. Future research might observe whether the pattern of cigarette ingestion has a differential effect upon cognition and PM performance, and could be coupled with other techniques, such as fMRI (functional magnetic resonance imaging) techniques, in order to pinpoint putative areas of any damage that might be incurred by prolonged smoking.

Another area for future research would be to compare different methods of nicotine ingestion, for example comparing the use of nicotine nasal sprays with other methods, such as nicotine patches, nicotine gum, alongside cigarettes to assess whether the type of method of administration (as well as manipulating different doses of nicotine) produce differential effects on PM performance. This may have the added advantage of testing what impact levels of CO may have upon PM performance, since this could be manipulated via these different methods of administration – testing one of the theories used to explain smoking-related PM deficits discussed throughout the thesis.

An area that warrants further investigation is that of teenage smoking. Given the increase in smoking in this age group (Amos & Bancroft, 2006) it is important that

the education and cessation programmes are intensified in order to alleviate the continuance of damage to the health and psychological well-being of this age group. Given the probability that brain development is still taking place in such a young age group (e.g. within the teenage years) it is important to assess what impact the use of substances such as smoking (and other recreational drugs) might have upon the development of the brain systems that underpin memory and PM in particular (Eisenberg & Forster, 2003; Fried, Watkinson & Gray, 2006; Swan & Lessov-Schlaggar, 2007). In addition, it may be advantageous to examine how smoking affects the different age ranges.   Are the patterns of PM deficits similar for the young, the middle-aged groups and the older portions of the smoking population?

The use of a real-world PM task is seen as particularly relevant, since this is where the impact of drug use (in this case smoking) is likely to affect the user the most. The use of laboratory-based tasks (for example the use of the PRVP and CAMPROMPT) do not contain the types of extraneous factors that appear in the real-world. For example, real-world tasks often have delays within them, distractions, and so on, and therefore provide more complex challenges to the participant. Real-world tasks should therefore be used more frequently in PM research, particularly drug-related research (a suggestion reinforced by current leading researchers within the area, (McDaniel & Einstein, 2007). The real world PM paradigms used here (in Studies 3 and 6) could also be extended in future research to include much more variable delays between the intention and the execution of the PM task. For example, diary studies might be useful so that one can compare what the person intended to do at the beginning of the week and what they actually

211

achieved during that week. This might increase the external validity of the tasks because it is similar to what one finds in the real world, for example arranging to meet with friends, go shopping, and so on, several days prior to carrying out these tasks. In short, the use of multiple tasks to remember and delays of varying length might reflect real-world situations more accurately than some of the methods used in the current thesis and would better reflect the use of PM in everyday life.

Along this methodological line, immersive Virtual Reality (VR) tasks use extensive technological equipment that could be used to provide an increasing number of what may be described as real-world tasks. Future research should utilise this technology to assess PM deficits associated with smoking and other substances. VR could provide laboratory-based controls with interactive real-time and event-based tasks that would be particularly useful in investigating PM and other related cognitive processes, such as executive processes (those processes involved in planning, monitoring and co-ordinating memory). VR tasks provide the obvious advantage in that it offers the opportunity to introduce more ecologically valid testing scenarios within a controlled laboratory-based environment using ever increasingly sophisticated dynamic scenarios, such as flight or driving simulations, virtual tours of a shopping scene, and so on (Rose, Brooks & Rizzo, 2005). The other advantage VR tasks have is that they enable the researcher to have absolute consistency in the procedure from participant to participant, something not achievable with laboratory-based or real-world tasks where slight/greater differences may occur between testing sessions.

It has been calculated that there are around 4000 different toxic chemicals to be found in tobacco smoke (Hoffmann & Hoffmann, 1998). Considerable examination has been undertaken on the effects of nicotine on cognition and memory (Rose, 2006; Okoli, Kelly & Hahn, 2007), but that is only one of the constituents of smoke. Perhaps future experiments could include the break-down and testing of these compounds of smoke to find out which constituents could particularly impair PM? For example, carbon monoxide is produced in higher than normal quantities when smoking, which then competes with oxygen for binding to haemoglobin cells which would normally carry high levels of oxygen to the brain. When competition from carbon monoxide is high, the system may become more saturated than normal with CO and therefore reduces oxygen levels required by the brain to carry out its functions, thus potentially reducing its associated functions such as memory and cognition. Therefore future research could attempt to understand what contribution carbon monoxide and other chemicals involved in smoking might have upon those systems that serve the brain and its functions, such as memory.

Future research could also look at the link between PM methods and other related processes, such as the central executive (CE) processes. CE is that part of memory that is involved in planning (including forming an intention to do something), co-ordinating information within memory, as well as retrieving information from memory. Kliegel et al (2008) suggested that at least part of PM is under executive control, specifically when one forms plan to do something at some future point in time (the intention formation) and when one initiates the plan (intention execution). The items/actions that are recalled are under retrospective

memory control (i.e. recalling the details of those items from long-term memory). Therefore it might be advantageous to look at both components within a PM paradigm in order to assess the relative contributions of each of these components. For example, if smokers show overall deficits in PM (as has been found in the present thesis) then it might be useful to identify where in the PM process the faulty memory occurs – at the executive stage or at the retrospective stage?

Another area to be considered would be that of second-hand smoke. It is now widely understood that the effects on people who work in environments that were clouded with smoke have been subjected to physiological problems, and in turn may suffer cognitive deficits as a consequence. Many people within the service sector (i.e. bars and restaurants had been continually subjected to second-hand smoke from their customers' habits). Therefore, it is equally possible that there could be cognitive deficits that could be the result of being in, or working in, an establishment that produced second-hand smoke. Perkins (2002) suggested that second-hand smoke could play a role in the onset of nicotine dependence and thereby most people affected by that type of atmosphere may well have been introduced to an initial smoking behaviour pattern. Future research could explore what (if any) damage prolonged exposure to second-hand smoke has upon a range of memory processes and PM in particular. It should be noted that it is not possible to carry out such research in the UK due to the ban on smoking within the workplace, but there is the possibility for research of this kind to be carried out within the home environment, for example, what impact second-hand smoking might have upon the developing child and its cognition. Also, it would be interesting to study what impact foetal

smoking (i.e. smoking when pregnant) might have upon the physiology and cognition of the developing child. It has been demonstrated that cigarette smoking during pregnancy diminishes the oxygen carrying capacity of foetal blood and diminishes the oxygen available to the foetus at the tissue level by its effect on foetal oxyhaemoglobin dissociation (Cole, Hawkins & Roberts, 2005). It is feasible that oxygen deprivation to the foetus as a result of maternal smoking may lead to cognitive deficits later in life, which may include PM deficits. Future researchers may wish to pursue this line of thinking.

8.6 Final Conclusions

From the research presented in the current thesis, a number of conclusions can be drawn. Firstly, it can be concluded from the lack of any consistent findings on the self-reported PM measures used here suggests that self-reports are not a reliable way of measuring deficits in PM. Secondly, the findings from a series of objective measures used in the present thesis support the notion that prolonged smoking is associated with impairments in PM. It is argued here that PM deficits need to be added to the growing list of neuropsychological deficits associated with prolonged smoking. However, one should be careful not to reach any firm conclusions about the association between smoking and PM based on only a handful of findings (as was found in the present thesis) and one should be aware that an association does not infer causality. Thirdly, it would appear from the findings of the previous smokers that smoking cessation leads to some recovery of function in PM. This third conclusion is important in terms of using such knowledge to encourage people to give up smoking in the light of improved health and, more relevant to this thesis,

improved everyday memory function in the form of PM. It can be concluded that the pattern of smoking, defined in the present thesis as social (binge) compared with regular (daily) smoking, does not produce any differential effects upon PM, rather it is smoking *per se* that causes the damage. Given the importance of PM to independent living, the findings from the present thesis could be used to educate younger, middle-aged and older people in terms of the negative cognitive consequences of smoking. These findings could also inform people in the medical profession about the cognitive deficits associated with smoking. Finally it is believed that these findings might provide an impetus for future research in the area.

REFERENCES

Allender, S., Peto, V., Scarborough, P., Boxer, A. and Rayner, M. (2006). *Coronary heart disease statistics*. British Heart Foundation. London.

Amos, A. and Bancroft, Y. (2006). Young people, smoking and gender – a qualitative exploration. *Health Education Research – Theory & Practice*. London: Oxford University Press.

Ambrose, J.A. and Barua, R.S. (2004). The Pathophysiology of Cigarette Smoking and Cardiovascular Disease. *Journal of American College of Cardiology, 43*, 1731-1737.

Baddeley, A.D. and Wilkins, A. (1984). Taking memory out of the laboratory. In J.E. Harris and P.E. Morris (Eds.), *Everyday memory, action and absent-mindedness*. London: Academic Press.

Baddeley, A.D. (1999). *Essentials of human memory*. Hove, UK: Psychology Press Ltd.

Baddeley, A.D., Cocchini, G., Della Salla, S., Logie, R.H. and Spinnler, H. (1999). Working Memory and Vigilance: Evidence from Normal Aging and Alzheimer's Disease. *Brain and Cognition, 41*, 87-108.

Baddeley, A.D., Eysenck, M.W. and Anderson M.C., (2009). *Memory*. Hove, UK. Psychology Press Ltd.

Balfour, D.J.K. (2006). Complementary roles for the accumbal shell and core in nicotine dependence. In: G. Bock and J.A. Goode (Eds.), *Understanding Nicotine and Tobacco Addiction,* Novartis Foundation Symposium 275, 96–115. Chichester and New York: Wiley.

Bancroft, A. and Levin, E.D. (2000). Ventral hippocampal alpha4beta2 nicotinic receptors and chronic and nicotine effects on memory. *Neuropharmacology, 39*, 2770-2778.

Barendregt, J.J., Bonneux, L. and Van De Maas, P.J. (1997). The health care costs of smoking. *New England Journal of Medicine, 337,* 1052–1057.

Bartholomew, J. and Holroyd, S. (2008). Do the prospective memory deficits associated with cannabis use in teenagers and young adults recover on cessation of use*? Journal of Czech and Slovak Psychiatry, 104*, p. 812.

Bartholomew, J., Holroyd, S. and Heffernan, T.M. (in press). Does cannabis use affect prospective memory in young adults? *Journal of Psychopharmacology.*

Bisiachi, P.S. (1996). The neuropsychological approach in the study of prospective memory. In M. Brandimonte, G. O. Einstein and M.A. McDaniel (Eds.), *Prospective Memory: Theory and Applications*. Mahwah, NJ: Erlbaum.

Brandimonte, M., Einstein, G.O. and McDaniel, M.A. (1996). *Prospective Memory: Theory and Applications*. Mahwah, NJ: Erlbaum.

Brender, E. (2006). Smoking Cessation. *Journal of the American Medical Association, 296(1)*, 130.

Breslau, N., Peterson, E.L., Schultz, L.R., Chilcoat, H.D. and Andreski, P. (1998). Major depression and stages of smoking: a longitudinal investigation. *Archives of General Psychiatry, 55,* 161-166.

Breslau, N., Kilbey, M.M. and Andreski, P. (1994). DSM-III-R nicotine dependence in the young adults: prevalence, correlates and associated psychiatric disorders. *Addiction, 89,* 743-754.

Brody, A.L. (2006). Functional brain imaging of tobacco use and dependence. *Journal of Psychiatric Research, 40*, 404-418.

Brody, A.L., Mandelkkern, M., Jarvik, M., Lee, G., Smith, E. Huang, J., et al. (2004). Differences between smokers and non-smokers and regional grey matter volumes and densities. *Biological Psychiatry, 55*, 77-84.

Buchanan, T., Ali, T., Heffernan, T.M., Ung, J., Parrott A.C., Rodgers, J. and Scholey, A.B. (2005). Non-equivalence of on-line and paper-and-pencil psychological tests: The case of the prospective memory questionnaire. *Behaviour Research Methods, Instruments & Computers, 37*, 148-154.

Burgess, P.W. and Shallice, T. (1997). The relationship between prospective and retrospective memory: Neuropsychological evidence. In M.A. Conway, (Ed.), *Cognitive Models of Memory*. Cambridge, MA: M I T Press.

Burgess, P. W., Quayle, A. and Frith, C. D. (2001). Brain regions involved in prospective memory as determined by positron emission tomography. *Neuropsychologia*, *39*, 545–555.

Cohen, D. and Barton, G. (1998). The cost to society of smoking cessation. *Thorax, 53(2),* 38–42.

Cohen, S. and Lichenstein, E. (1990). Perceived stress, quitting smoking and smoking relapse. *Health Psychology, 9*, 466-478.

Cohen, J.D. and O'Reilly, R.C. (1996). A preliminary theory of the interactions between Prefrontal Cortex and Hippocampus that contribute to Planning and Prospective Memory. In M.A. Brandimonte, G.O. Einstein and M.A. McDaniel, (Eds.). *Prospective Memory: Theory and Applications.* Mahwah, N J: Erlbaum.

Cole, P.V., Hawkins, L.H. and Roberts, D. (2005). Smoking during pregnancy and its effects upon the foetus. *BJOG: International Journal of Obstetrics & Gynaecology, 79,* 782-787.

Comer, R.J. (2007). *Abnormal Psychology (6th edition).* New York: Worth publishers.

Corrigall, W.A. and Coen, K.M. (1989). Nicotine maintains a robust self-administration in rats on a limited-access schedule. *Psychopharmacology, 99*, 473-478.

Corwin, E.J. (2002). Predictors of Fatigue in Healthy Young Adults: Moderating Effects of Cigarette Smoking and Gender. *Biological Research for Nursing, 3*, 222-233.

Crawford, J., Deary, I.J., Starr, J. and Whalley, L.J. (2001). The NART as an index of prior intellectual functioning: a retrospective validity study covering a 66-year interval. *Psychological Medicine, 31*, 451-458.

Crawford, J., Smith, G., Maylor, E., Della Sala, S. and Logie, R. (2003). The Prospective and Retrospective Memory Questionnaire (PRMQ): Normative data and latent structure in a large non-clinical sample. *Memory, 11,* 261-275.

Dalgleish, T. and Cox, S. (2000). Mood and memory. In G.E. Berrios and J.R. Hodges (Eds). *Memory disorders in psychiatric patients (Chapter 2).* New York: Cambridge University Press.

Dani, J.A. and Heinemann, S. (1996). Molecular and cellular aspects of nicotine abuse. *Neuron, 16(5)*, 905-908.

Deary, I.J., Pattie, A., Taylor, M.D., Whiteman, M.C., Starr, J.M. and Whalley, L.J. (2003). Smoking and cognitive change from age 11 to age 80. *Journal of Neurology, Neurosurgery and Psychiatry, 74*, 1006-1007.

Department of Health Bulletin, (1998). London. Department of Health.

Department of Health Survey, 2000. Smoking, drinking and drug use among young people in England in 2000. London. Department of Health.

Department of Health and Social Services, (1999). *Drug misuse and dependence: guidelines on clinical management*. Belfast. Department of Health & Social Services.

Diaz-Asper, C., Schretlen., D.J. and Pearlson, G.D. (2004). How well does IQ predict *Journal of the International Neuropsychological Society, 10(1),* 82-90.

Dieckman, P., Redderson, S., Wehener, T. and Rall, M. (2006). Prospective memory failures as an unexplored threat to patient safety: Results from a pilot study using patient simulators to investigate the missed execution of intentions. In M.A. McDaniel and G.O. Einstein, (Eds.). *Prospective Memory: An overview and synthesis of an emerging field.* Thousand Oaks. Sage Publications Inc.

Dwyer, J.B., Broide, R.S. and Leslie, F.M. (2008). Nicotine and Brain Development. *Birth Defects Research, 84*, 30-40.

Eich, E., Macaulay, D. and Ryan, L. (1994). Mood dependent memory for events of the personal past. *Journal of Experimental Psychology, 123*, 201-215.

Eich, E. (1995). Searching for mood dependent memory. *Psychological Science, 6*, 67-75.

Eisenberg, M.E. and Forster, J.L. (2003). Adolescent smoking behaviour. *American Journal of Preventive Medicine, 25*, 122-128.

Einstein, G.O. and McDaniel, M.A. (1990). Normal ageing and prospective memory. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *16*, 717-726.

Ellis, J.A. (1988). Memory for future intentions: investigating pulses and steps. In: M.M. Gruneberg, P.E. Morris and R.N. Sykes, (Eds.). *Practical Aspects of Memory: Current Research and Issues: Vol. 1. Memory in Everyday Life*. Chichester, UK, Wiley.

Epping-Jordan, M.P., Watkins, S.S., Koob, G.F. and Markou, A. (1998). Dramatic decreases in great moral ward function during nicotine withdrawal. *Nature, May,* 76-79.

Ernst M., Heishman, S.J., Spurgeon, L. and London, E.S. (2001a). Smoking history and nicotine effects on cognitive performance. *Neuropsychopharmacology, 25*, 313-390.

Evans, D.E. and Drobes, D.J. (2008). Nicotine self-medication of cognitive-attentional processing. *Addiction Biology, 14*, 32-42.

Folstein, M.F., Folstein, S.E. and McHugh, P.R. (1975). 'Mini-mental state': A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12,* 189-198.

Forster, A. (2003). *Investigating central executive deficits in adult dyslexics, and its relationship with prospective memory*. Undergraduate Psychology Project. UK: Northumbria University.

Fried, P.A., Watkinson, B. and Gray, R. (2006). Neurocognitive consequences of cigarette smoking in young adults - a comparison with pre-drug performance. *Neurotoxicology & Teratology, 28*, 517-525.

Galanis, D.J., Petrovitch, H., Launer, L.J., Harris, T.B., Foley, D.J. and White, L.R. (1996). Smking history in middle age and subsequent cognitive performance in elderly Japanese-American men. *American Journal of Epidemiology, 145(6),* 507-515.

General Household Survey, (2007). London. Office for National Statistics.

General Household Survey, (2009). London. Office for National Statistics.

Giannakoulas, G., Katramadas, A., Melos, N., Diamantopoulos, I. and Chimonas, E. (2003). Acute Effects of Nicotine Withdrawal Syndrome in Pilots During Flight. *Aviation, Space and Environmental Medicine, 74(3)*, 247-251

Glass, J.M., Buu, A., Adams, K.M., Nigg, J.T., Puttler, L.I., Jester, J.M. and Zucker R.A. (2009). Effects of alcoholism severity and smoking on executive neurocognitive function. *Addiction, 104*, 38-48.

Godfrey, C., Edwards, H., Raw, M., & Sutton, M. (1993). *The smoking epidemic: a prescription for change*. London. Health Education Authority

Gonzales, M.A. and Harris, M.B. (1980). Effects of cigarette smoking on recall and categorisation of written material. *Perceptual and Motor Skills, 50*, 407-41

Graf, P. and Uttl, B. (2001). Prospective memory: A new focus for research. *Consciousness and Cognition 10(4),* 437-450.

Guynn, M.J., McDaniel, M.A. and Einstein, G.O. (1998). Prospective Memory: When reminders fail. *Memory & Cognition, 26*, 287-298.

Halpern-Felsher, B.L., Biehl, M., Kropp, R.Y. and Rubinstein, M.L. (2004). Perceived risks and benefits of smoking: differences among adolescents with different smoking experiences and intentions. *Preventive Medicine, 39,* 559-567.

Hakkarainen, P. and Metso, L. (2009). Joint Use of Drugs and Alcohol. *European Addiction Research,* 15, 113-120

Hamill, W. and O'Neill, R.P. (1969). Carbon monoxide intoxication in cigar smokers. *Irish Journal of Medical Science, 8*, 273-277.

Hannon, R., Adams, P., Harrington, S., Fries-Dias, C. and Gibson, M.T. (1995). Effects of brain injury and age on prospective memory self-rating and performance. *Rehabilitation Psychology, 40(4),* 289-297.

Harris, R. and Hatton, J. (1998). *Murder a Cigarette: The Smoking Debate*. London. Duckworth.

Harris, L.M. and Menzies, R.G. (1999). Mood and prospective memory. *Memory, 7(1)*, 117-127.

Harrison, E.L.R. and McKee, S.A. (2008). Young adult non-daily smokers: Patterns of alcohol and cigarette use. *Addictive Behaviours, 33*, 668-674.

Heffernan, T.M. (2008). The impact of excessive alcohol use on prospective memory: A brief review. *Current Drug Abuse Reviews, 1, 36-41.*

Heffernan, T.M. and Bartholomew, J. (2006). Does excessive alcohol use in teenagers affect their everyday prospective memory? *Journal of Adolescent Health, 39,* 138-140.

Heffernan, TM. and Bellis, C. (2008). Does prolonged use of MDMA or 'Ecstasy' affect everyday prospective memory? *Journal of Czech and Slovak Psychiatry, 104(2),* 831.

Heffernan, T.M., Jarvis, H., Rodgers, J., Scholey, A.B. and Ling, J. (2001). Prospective memory, everyday cognitive failures and central executive functions in recreational users of 'ecstasy'. *Human Psychopharmacology: Clinical & Experimental, 16,* 607-612.

Heffernan, T.M., Ling, J., Parrott, A.C., Buchanan, T., Scholey, A.B. and Rodgers, J. (2005). Self- rated everyday and prospective memory abilities of cigarette smokers and non-smokers: A web-based study. *Drug and Alcohol Dependence*, *78,* 235-241.

Heffernan, T.M., Moss, M. and Ling, J. (2002). Subjective ratings of prospective memory in chronic heavy alcohol users. *Alcohol and Alcoholism, 37,* 269-271.

Heishman, S.J. (1998). What aspects of human performance on truly enhanced by nicotine? *Addiction, 93*, 317-320.

Heishman, S.J., Taylor, R.C. and Henningfield, J.E., (1994). Nicotine and smoking: a review of effects on human performance. *Experimental and Clinical Psychopharmacology, 2*, 345–395.

Heishman, S.J. and Henningfield, J.E., (2000). Tolerance to repeated nicotine administration on performance, subjective and physiological responses in non-smokers. *Psychopharmacology, 152(3)*, 321-333

Hendriks, P. and Brandon, T.H. (2008). Smokers' expectancies for smoking versus nicotine. *Psychology of Addictive Behaviours, 22*, 135-140.

Henningfield, J.E. and Zeller, M. (2006). Nicotine psychopharmacology research contributions to United States and global tobacco regulation: a look back and a look forward. *Psychopharmacology, 184,* 286–291.

Hill, R.D. and Seelert, K.S. (2000). Cigarette smoking and cognitive function. In R.D. Hill, L. Backman and A.S. Neely, (Eds.). *Cognitive rehabilitation in All Ages*. New York. Oxford University Press.

Hill, R.D., Nilsson, L-G., Nyberg, L. and Backman, L. (2003). Cigarette smoking and cognitive performance in healthy Swedish adults. *Age and Ageing 32(5),* 548-550.

Hodgson, T.A. (1992). Cigarette smoking and lifetime expenditures. The *Millbank Quarterly, 70*, 81–125.

Hoffmann, D. and Hoffmann, I., (1998). Chemistry and Toxicology. In National Cancer Institute : *Smoking and Tobacco Control, Monograph No 9,* 55-104. U.S. Department of Health and Human Services, National Institutes of Health. USA.

Hopkins, P.O. and Woon, FLM. (2006). Neuroimaging, cognitive, and neurobehavioral outcomes of carbon monoxide poisoning. *Behavioural and Cognitive Neuroscience Reviews, 5,* 141-155.

Hughes, J.R., Gulliver., S.B., et al. (1992). Smoking cessation amongst self-quitters. *Health Psychology, 11(5),* 331-334.

Hulihan-Giblin, B.A., Lumpkin, M.D. and Keller, K.J. (1997). Effects of chronic administration of nicotine on prolactin release in the rat: Inactivation of prolactin release by repeated injections of nicotine. *Journal of Pharmacology Experiment and Theory, 252,* 21-25.

Huppert, F.A., Johnson, A. and Nickson, J. (2000). High prevalence of prospective memory impairment in the elderly and in early-stage dementia: Findings from a population-based study. *Applied Cognitive Psychology, 14 (Special issue),* S 63-S 81.

Jacobson, J.L., Krystal, J.H., Mencl, W.E., Westervelt, M., Frost, S.J. and Pugh, K.R. (2005). Acute and chronic effects of smoking on adolescent smokers. *Biological Psychiatry, 57*, 56-66.

Jardine, J. (2002). *Subjective ratings and objective performance of prospective memory in recreational ecstasy users.* Unpublished Undergraduate Psychology Project. UK: Northumbria University.

Jarvis, M. J. and Wardle, J. (1999). Social patterning of individual health behaviours: the case of cigarette smoking. In M. Marmot, & R. Wilkinson, (Eds.). *Social determinants of health.* Oxford: Oxford University Press.

Jarvis, M.J. (2001); Why people smoke. *British Medical Journal, 328*, 277-279

Johnson, P.B., Boles, S.M., Vaughan, R and Kleber, H.D. (2000). The co-occurrence of smoking & binge drinking in adolescence. *Addictive Behaviours, 25(5)*, 779-783.

Jones, S., Sudweeks, S. and Yakal, J.L. (1999). Nicotinic receptors in the brain: correlating physiology with function. *Trends in Neurosciences, 22*, 555-561.

Kalmijn, S., van Botel, M.P.J., Verschuren, M.W.M., Jolles, J. and Launer, L.J. (2002). Cigarette smoking and alcohol consumption in relation to cognitive performance in middle age. *American Journal of Epidemiology, 156*, 936-944.

Kassel, J. D., Evatt, D. P., Greenstein, J. E., Wardle, M. C., Yates, M. C. and Veilleux, J. C. (2007). The acute effects of nicotine on positive and negative affect in adolescent smokers. *Journal of Abnormal Psychology, 116(3),* 543-553

Kendler, K.S., Neale, M.C., MacLean, C.J., Heath, A.C., Eaves, L. and Kessler, R. (1993). Smoking and major depression: a causal analysis. *Archives of General Psychiatry, 50*, 36-43.

Kiernan, V.G. (1991). *Tobacco: a history.* London. Hutchinson Radius.

Kinnear, P.R. and Gray, C.D. (2008). *SPSS 15 made simple*. Hove. Psychology Press

Kliegel, M., Jager, T., Altgassen, M. and Shum, D. (2008). Clinical neuropsychology of prospective memory. In M. Kliegel, M.A. McDaniel and G.O. Einstein. *Prospective Memory: Cognitive, Neuroscience, Developmental and Applied Perspectives*. New York. Lawrence Erlbaum Associates.

Kliegel, M., McDaniel, M.A. and Einstein, G.O. (2008). *Prospective Memory: Cognitive, Neuroscience, Developmental and Applied Perspectives*. New York. Lawrence Erlbaum Associates.

Kluger, R. (1996). *Ashes to Ashes: America's Hundred-Year Cigarette War, the PublicHealth: an unabashed triumph of Philip Morris.* New York. Knopf.

Knott, V. and Harr, A. (1997). Acute/chronic effects of smoking on memory scanning: Behavioural performance and event-related potentials in young and elderly adults. *Brain and Cognition, 35(3)*, 331-332.

Kopp, U.A. and Thone, A.I.T.(2000). Role of executive functions and memory processes in delayed intention after head injury. *Paper presented at the 1st International Conference on Prospective Memory.*

Lader, D. and Meltzer, H. (2003). *Smoking-related behaviour and attitudes, 2002.* London. Office for National Statistics.

Levin, E.D., McClernon, F.J. and Rezvani, A.H. (2006). Nicotinic effects on cognitive function: behavioural characterisation, pharmacological specification and anatomic localisation. *Psychopharmacology, 184*, 523-539

Levin, E.D., Sledge, D.M., Baruah, A. and Addy, N.A. (2003). Ventral hippocampal NMDA blockade and nicotinic effects on memory function. *Brain Research Bulletin, 61(5)*, 489-495.

Ling, J., Heffernan ,T.M., Buchanan, T., Rodgers, J., Scholey, A.B. and Parrott, AC. (2003). Effects of Alcohol on Subjective Ratings of Prospective and Everyday Memory Deficits. *Alcoholism: Clinical and Experimental Research, 27(6),* 1-5.

McDaniel, M.A. and Einstein, G.O. (2007). *Prospective Memory: An overview and synthesis of an emerging field.* London. Sage Publications.

McDaniel, M.A., Glisky, E.L., Guynn, M.J. and Rotherieaux, B.C. (1999). Prospective memory: A neuropsychological study. *Neuropsychology, 13*, 103-110.

McFarland, C.P. and Glisky, E.L. (2009). Frontal lobe involvement in a task of time-based prospective memory. *Neuropsychologia, 47(7),* 1660-1669.

McGillion, J., Wanigaratne, S., Feinmann, C., Godden, T. and Byrne A. (2000). GPs' attitudes towards the treatment of drug misusers. *British Journal of General Practitioners*, 385-386.

McNamara, D., Larson, D.M., Rappoport, S.I. and Sonscrant, T.T. (1990). Preferential metabolic activation of subcortical brain areas by acute administration of nicotine to rats. *Journal of Cerebral Blood Flow and Metabolism, 10*, 48-56.

Mendrek, A., Monterosso, J., Simon, S.L., Jarvik, M., Brody, A., Olmsted, R., Domier, C.P., Cohen, M.S., Ernst, M. and London, E.D. (2006). Working memory in cigarette smokers: Comparison to non-smokers and effects of abstinence. *Addictive Behaviours, 31*, 833-844.

Mannino, D. M . and Buist, A.S. (2007). Global burden of COPD: risk factors, prevalence, and future trends. *The Lancet, 370 (9589),* 765-773

Marchant, N.L., Trawley, S. and Jennifer M. Rusted, J.M. (2008). Prospective memory or prospective attention: Physiological and pharmacological support for an attentional model. *International Journal of Neuropsychopharmacology, 11*, 401-411.

Marsh, R.L. and Hicks, J.L. (1998). Event-based prospective memory and executive control of working memory. *Journal of Experimental Psychology: Learning, Memory and Cognition, 24*, 336-349.

Mermelstein, R. (2003). Teen smoking cessation. *Tobacco Control, 12*(1), 25-34.

Meyer, J., Rauch, G.M., Crawford, K., Rauch, R.A., Konno, S, Akiyama, H., Terayama, Y. and Haque, A. (1999). Risk factors accelerating cerebral degenerative changes, cognitive decline and dementia. *International Journal of Geriatric Psychiatry, 14,* 1050-1061.

Mitchell, S.H. (1999). Measures of impulsivity in cigarette smokers and non-smokers. *Psychopharmacology, 146(4),* 455-464.

Moran, S., Wechsler, H. and Rigotti, N.A. (2009). Social smoking among US college students. *Pediatrics, 114,* 1028-1034.

National Treatment Agency for Substance Misuse, (2002). Model of care for treatment of adult drug misusers: framework for developing local systems of effective drug misuse in England. London. Department of Health.

Neisser, U. (1978). Memory: What are the important questions? In M.M. Gruneberg, P.E. Morris and R.N. Sykes (Eds.). *Practical aspects of memory*. New York. Freeman.

Nelson, H.E. (1982). *The National Adult Reading Test.* Berkshire. NFER-Nelson.

Nelson, H. E. and Willison, J. (1991). National Adult Reading Test (NART) manual (2nd edn.). Windsor, UK. NFER-Nelson.

Nooyens, A.C.J., van Gelder, B.M. and Verschuren, W.M.M. (2008). Smoking and cognitive decline among middle-aged men and women: The Doetinchen cohort study. *American Journal of Public health, 98(12),* 1- 7.

Office for National Statistics, (2001). *Living in Britain*. London: The Stationery Office.

Office for National Statistics. (1997). *Living in Britain*. London: The Stationery Office,

Okoli, C.T.C., Kelly, T. and Hahn, E.J. (2007). Second-hand smoke and nicotine exposure: A brief review. *Addictive Behaviours, 32*, 1977-1988.

Okuda, J., Fujii, T., Yamadori, A., Kawashima, R., Tsukiura, T., Fukatsu, R., Suzuki, K., Ito, M. and Fukukla, M. (1998). Participation of the prefrontal cortices in prospective memory: evidence from a PET study in humans. *Neuroscience Letters, 253*, 127-130.

Parrott, A.C., Garnham, N.J., Wesnes, K. and Peacock, C. (1996). Cigarette smoking and abstinence: Comparative effects upon the cognitive task performance and mood state over 24 hours. *Human Psychopharmacology: Clinical and Experimental, 11(5),* 391-400.

Parrott, A.C. (1998). Nesbitt's paradox resolved? Stress and arousal modulation during cigarette smoking, *Addiction, 93(1)*, 27-39.

Parrott, A.C. and Garnham, N.J. (1998). Comparative mood states and cognitive skills of cigarette smokers, deprived smokers and non-smokers. *Human Psychopharmacology, Clinical and Experimental, 13(5)*, 367-376.

Parrott AC. (1999). Does cigarette smoking increase stress? *American Psychologist, 54,* 817–820.

Parrott, A.C., Morinan, A., Moss, M. and Scholey, A. (2004). *Understanding Drugs and Behaviour.* Chichester, UK. Wiley.

Parrott, S., Godfrey, C. and Raw, M. (1996). *Cost and benefit analysis of smoking cessation in the workplace*. Final report to the Health Education Board for Scotland. University of York: Centre for Health Economics, York.

Paul, R., Brickman, A.M., Cohen, R., Williams, I.M., Niaura, R., Pogun, S., Clark, C.R., Gunstad, J. and Gordon, E. (2006). Cognitive status of young and older cigarette smokers. *Journal of Clinical Neuroscience, 13*, 457-465.

Perkins, K.A. and Stitzer, M. (1998). Behavioural pharmacology of nicotine. In R. Tarter, R.T. Ammerman and P. Otte (Eds.). *Handbook of substance abuse: new role behavioural pharmacology*. New York. Plenum Press.

Perkins, K.A. (2002). Chronic tolerance to nicotine in humans and its relationship to tobacco dependence. *Nicotine & Tobacco Research, 4(4)*, 405-422.

Peters, R. and McGee, R. (1982). Cigarette smoking and state-dependent memory. *Psychopharmacology, 76*, 232-235.

Pianezza, M.L., Sellers, E.M. and Tynedale, R.F. (1998). Nicotine metabolism defect reduces smoking. *Nature, 393*: 750.

Pinenda, J., Herrera, C., Kang, C. and Sandle, A. (1998). Effects of cigarette smoking and 12-h abstention of working memory during a serial probe recognition task. *Psychopharmacology, 139(4)*, 311-321.

Pitel. A.L., Rivier, J., Beaunieux, H., Vabret, F., Desgranges, B. and Eustache, F. (2008). Changes in the Episodic Memory and Executive Functions of Abstinent and Relapsed Alcoholics Over a 6-Month Period. *Alcoholism: Clinical and Experimental Research, 33(3),* 490- 498.

Pomerleau, C.S. and Pomerleau, O.F. (1992). Euphoriant effects of nicotine in smokers. *Psychopharmacology, 108*, 460-465.

Powdthatres, N. and Vignoles, A. (2008). *The socio-economic gap in university drop out.* Discussion paper in Economics (Online), University of York. Web link: https://www.york.ac.uk/depts/econ/documents/dp/0823.pdf

Provost, S.C. and Woodward, R. (1991). Effects of nicotine gum on repeated administration of the Stroop test. *Psychopharmacology, 104*, 536-540.

Rash, C.J. (2007). *Effects of smoking and nicotine withdrawal on prospective memory*. Unpublished PhD Dissertation. USA. Louisiana State University.

Report of the Scientific Committee on Tobacco and Health, (1998). London. Department of Health.

Richards, M., Jarvis, M.J., Thompson, N. and Wadsworth, M.E.J. (2003). Cigarette Smoking and Cognitive Decline in Midlife: Evidence from a Prospective Birth Cohort Study. *American Journal of Public Health, 93(6)*, 994-998.

Robson, C. (2002). Real *World Research: A Resource for Social Scientists and Practitioner Researchers (2nd edition).* London. Blackwell Publishing.

Rodgers, J., Buchanan, T., Scholey, A.B., Heffernan, T.M., Ling, J. and Parrott, A.C. (2003). Patterns of drug use and the influence of gender on self reports of memory ability amongst ecstasy users: A web based study. *Journal of Psychopharmacology. 17(4),* 379-386.

Rodgers, J., Buchanan, T., Scholey, A.B., Heffernan, T.M., Ling, J. and Parrott, A. (2001). Self-reports of Memory Ability in Recreational Users of cannabis and 'Ecstasy': A web-based study. *Human Psychopharmacology: Clinical & Experimental, 16,* 619-625.

Rose, J.E. (2006). Nicotine and non-nicotine factors in cigarette addiction. *Psychopharmacology, 184*, 274–285.

Rose, F.D., Brooks, B.M. and Rizzo, A.A. (2005). Virtual reality in brain damaged patients: A review. *Cyber Psychology and Behaviour, 8(3),* 241-261.

Roth, N., Lutiger, B., Hasenfratz, M., Battig, K. and Knye, M. (1992). Smoking deprivation in early and late smokers and memory functions. *Psychopharmacology, 106*, 253-260.

Royal College of Physicians. (2007). *Nicotine Addiction in Britain*. A report of the Tobacco Advisory Group, October 2007.

Royal College of Physicians. (2002). *Nicotine Addiction in Britain*. A report of the Tobacco Advisory Group, May 2002.

Rusted, J.M. and Trawley, S. (2006). Comparable Effects of Nicotine in Smokers and Non-smokers on a Prospective Memory Task. *Neuropsychopharmacology, 31*, 1545-1549.

Rusted, J.M., Trawley, S., Heath, J., Kettle, G. and Walker, H. (2005). Nicotine improves memory for delayed intentions. *Psychopharmacologia, 182*, 355-365.

Rusted, J.M., Graupner, L., Tennent, A. and Warburton, D.M. (1998). Effortful processing is a requirement for nicotine-induced improvements in memory. *Psychopharmacology, 138*, 362-368.

Sabia S., Marmot M., Dufouil C. and Singh-Manoux A. (2008). Smoking history and cognitive function in middle age from the Whitehall II study. *Archives of Internal Medicine, 168(11)*, 1165-73.

Sakurai, Y. and Kanazawa, I. (2002). Acute effects of cigarettes in non-deprived smokers on memory, calculation and executive functions. *Human Psychopharmacology, 17(7)*, 369-373.

Scholey, A.B., Parrott, A.C., Buchanan, T., Heffernan, T.M., Ling, J. and Rodgers, J. (2004). Increased intensity of Ecstasy and polydrug usage in the more experienced recreational Ecstasy/MDMA users: A www study. *Addictive Behaviour ,29,* 743-752.

Seed, JA., Dahabra, S., Heffernan, TM., Robertson, B., Foster, K, Venn, H., Froom, K. and Williams, T. (2005). Everyday memory and related processes in patients

with eating disorders. *Clinical Effectiveness in Nursing, 8,* 176-188

Sherwood N. (1993). Effects of nicotine on human psychomotor performance. *Human Psychopharmacology, 8*, 155–184.

Sherwood, N. (1993). Effects of nicotine on human psychomotor performance. *Human Psychopharmacology, 8*, 155–184.

Siennicki-Lantz, A., Lilja. B. and Elmstahl, S. (2002). Cerebral perfusion deficits in age-associated memory impairment. The role of tobacco smoking. *Aging Clinical Experimental Research, 14(2)*, 108-116.

Simons, J.S., Scholvinck,M.L., Gilbert, S.J., Frith, C.D. and Burgess, P.W. (2006). Differential components of prospective memory? Evidence from fMRI. *Neuropsychologia, 44*, 1388–1397.

Snaith, R. P. and Zigmond, A. S. (1994). *HADS: Hospital Anxiety and Depression Scale*. Windsor: NFER Nelson.

Spear, L.P. (1997). Adolescence as a vulnerable period for neurobehavioural toxicity. *Neurotoxicity and Teratology, 19(3)* p.239.

Spilich, G.J., June, L. and Renner, J. (1992). Cigarette smoking and cognitive performance. *British Journal of Addiction, 87*, 1313-1326.

Spiro, S. (2003). Warning to Saturday day night 'binge' smokers. ASH Daily News, for 01.12.2003. London: Action on Smoking and Health.

Stoddard, J.J. and Gray B. (1997). Maternal smoking and medical expenditures for childhood respiratory illness. *American Journal of Public Health, 87,* 205–9.

236

Stolerman, I.P. (1992). Drugs of abuse: behavioural principles, methods and terms. *Trends in Pharmacological Sciences, 13*, 170-176.

Stolerman, I.P. and Jarvis, M.J. (1995). The scientific case that nicotine is addictive. *Psychopharmacology, 117*: 2-10.

Stump, T.E., Callahan, M. and Hendrie, H.C. (2001). Cognitive impairment and mortality in older primary care patients. *Journal of American Geriatric Society, 49*, 934-940.

Swan, G.E. and Lessov-Schlaggar, C.N. (2007). The effects of tobacco and nicotine on cognition and the brain. *Neuropsychological Review, 17*, 259-273.

Tait, R., Martin-Iverson, M., Michie, P.T. and Dusci, L. (2000). The effects of cigarette consumption on the Sternberg visual memory search paradigm. *Addiction, 95(3)*, 437-446.

Tengs, T.O. and Osgood, N.D. (2001). The Link between Smoking and Impotence: Two Decades of Evidence. *Preventive Medicine, 3*2, 447-452

Titov, M. and Knight, R.G. (2001). A video based procedure for the assessment of Prospective Memory. *Applied Cognitive Psychology, 15,* 61-83.

US Surgeon-General's Report, 1988. *The Health Consequences of Smoking: Nicotine Addiction.* Washington, DC, USA. US Government Printing Office.

Vardavas, C., Kondilis, B., Travers, M.J., Petsetaki, E., Tountas, Y. and Kafatos, A. (2007). Environmental tobacco smoke in hospitality venues in Greece. *BMC Public Health*, *7,* 302.

Vierola, H. (1998). *Tobacco and women's health.* Helsinki: Art House Oy.

Wakefield, M., Flay, B., Nichter, M. and Giovino, G. (2003). Role of the media in trajectories of youth smoking. *Addiction, 98*, 79-103.

Warburton, D.M. and Arnall, C. (1994). Improvements in performance without nicotine withdrawal. *Psychopharmacology, 115*, 539-542.

Warburton, D.M., Revell, A. and Walters, A.C. (1988). Nicotine as a resource. In M.J. Rand and K. Thurau (Eds.). *The pharmacology of nicotine*. London. ICSU Press.

Warburton, D.M., Skinner, A. and Martin, C.D. (2001). Improved incidental memory with nicotine after semantic processing, but not after phonological processing. *Psychopharmacology, 153(2),* 258-263.

Waters, A.J. and Sutton, S.R., (2000). Direct and indirect effects of nicotine/smoking on cognition in humans. *Addictive Behaviours, 25*, 29-43.

Waters, A.J. and Sayette, M.A. (2006). Implicit cognition and tobacco addiction. In: R.W. Wiers and A.W. Stacy (Eds.). *Handbook of implicit cognition and addiction*. London: Sage Publications.

Wesnes, K. and Parrott, A.C. (1992). Smoking, and nicotine and human performance. In A. Smith and D. Jones (Eds.). *Factors affecting human performance, Volume 2.* London. Academic Press Ltd.

Wesnes, K. and Warburton, D.M. (1983). The effects of cigarettes of varying yield on rapid information-processing performance. *Psychopharmacology, 82*, 338-342.

West, R., Jarvis, M.J ., Russell, M.A.H. , Carruthers, M.E. and Feyerabend. C. (1984). Effect of nicotine replacement on the cigarette withdrawal syndrome. *British Journal of Addiction, 79,* 215-219.

West, R. (1988). Prospective memory and aging. In: M.M. Gruneberg, P.E. Morris, and R.N. Sykes (Eds.). *Practical aspects of memory: current research and issues. Clinical and educational implications, vol. 2*. Chichester, UK. Wiley.

West, R. (1993). Beneficial effects of nicotine: act or fiction? *Addiction, 88*, 589-590.

Whitesel, J. (2003). *Social Smoking*. Paper presented at the annual meeting of the American Sociological Association, Atlanta Hilton Hotel, Atlanta, GA, Aug 16, 2003.

Whittington, J.E. and Huppert, F.A. (1997). Smoking and Cognitive Decline. Human *Psychopharmacology, 12*, 467-480

Wilson, B.A., Emslie, H., Foley, J., Shiel, A., Watson, P., Hawkins, K., Groot, Y. and Evans, J. (2005). *The Cambridge Prospective Memory Test*. London. Harcourt.

Winograd, E. (1988). Some observations on prospective remembering. In M.M. Gruneberg, P.E. Morris and R.N. Sykes (Eds.). *Practical aspects of memory: Current research and issues (Vol. 1)*. Chichester, UK. Wiley.

World Health Organisation, (2004). Changing History; Geneva

World Health Organisation (1969). *Technical Report Series No. 407*. Geneva.

Xu, J., Mendrek, A., Cohen, M.S., Monterosso, J., Rodriguez, P., Simon, S.L., Brody, A., Jarvik, M., Domier, C.P., Olmstead, R., Ernst, M. and London, E.D. (2005). Brain Activity in Cigarette Smokers Performing a Working Memory Task: Effect of Smoking Abstinence. *Biological Psychiatry, 58*, 143-150

Zigmond, A.S. and Snaith, R.P. (1983). The Hospital Anxiety and Depression Scale. *Acta Psychiatrica Scandinavica, 67*, 361-370.

APPENDIX 1:

The Drug Use Questionnaire adapted from Heffernan et al., 2005.

Age…………. Gender…..

The following questions relate to substances you may use. Please answer all questions as truthfully and accurately as you can (remember your answers are completely anonymous).

---

1. Do you smoke?   Yes ☐₁   No   ☐₂

    a. How many cigarettes do you usually smoke each week?   _____
    b. How many years have you been smoking cigarettes?   _____
    c. How long is it since your last cigarette?   _____

2. Do you drink alcohol?   Yes ☐₁   No   ☐₂   **If no please go to question 3**

    a. How many 'sessions' per week (e.g. 1, 2) do you typically spend drinking?   _____

    b) How many units do you typically drink per session, using the guide that follows and listing in the table immediately below? (Guide: 1 unit = ½ pint of beer or lager, 1 standard glass of wine, 1 measure of spirits or 1 alcopop)?

Session Number Within One Week	Number of units or list drinks consumed (eg 5 pints lager/2 shots of vodka, etc.
Session 1	
Session 2	
Session 3	
Session 4	
Session 5	
Session 6	

    c. How many years have you been drinking alcohol?   _____
    d. How long is it since your last alcoholic drink?   _____

3. Have you ever used any other recreational drugs? Yes ☐₁ No ☐₂
   Which recreational drugs do/did you use?

Recreational drug used?	Current or previous use?	Frequency of use (daily, weekly, at least once per month, less than once per month)?	Amount used on each occasion	Last use?
e.g. Ecstasy	current	Less than once per month	1 pill	2 weeks ago
e.g. Cannabis	current	Twice per month	3 joints	1 week ago

APPENDIX 2:
The Prospective Memory Questionnaire developed by Hannon et al., 1995.

Please answer the questions to the best of your knowledge. For each item, select the place on the line which best indicates your behaviour during the past week or month or year, as indicated below the item. Circle the slash you select as demonstrated in the example below:

I forgot to water my plants.

|-----|-----|-----|--(--|-)---|-----|-----|-----| NA
(never)   (2 times/   (4 or more
                       month)   times/month)

The person responding to the above question forgot to water his/her plants approximately 3 times during the past month. If the item does not apply to you during the time specified, circle NA next to the item (for not applicable). For example, if you have no plants, you would respond as demonstrated in the example below:

I forgot to water my plants.

|-----|-----|-----|-----|-----|-----|-----|-----| (NA)
(never)   (2 times/   (4 or more
                       month)   times/month)

Again, be sure to respond to each item. Thank you very much for your help.

1. I missed appointments I had scheduled (during the last month).
   |-----|-----|-----|-----|-----|-----|-----|-----| NA
   (never)   (3 times/   (6 or more
                          month)   times/month)

2. I forgot to follow a change in my usual routine (during the last month)
   |-----|-----|-----|-----|-----|-----|-----|-----| NA
   (never)   (2 times/   (4 or more
                          month)   times/month)

3. I forgot to send a card for a birthday or anniversary (during the last year)
   |-----|-----|-----|-----|-----|-----|-----|-----| NA
   (never)   (3 times/   (6 or more
                           year)   times/year)

4. I forgot to make an important phone call (during the last week).
   |-----|-----|-----|-----|-----|-----|-----|-----| NA
   (never)   (2 times/   (4 or more
                           week)   times/week)

5. I told someone something that I did not mean to tell (during the last month).
   |-----|-----|-----|-----|-----|-----|-----|-----| NA
   (never)   (2 times/   (4 or more
                          month)   times/month)

6. I forgot to return something I borrowed (during the last month).
   |-----|-----|-----|-----|-----|-----|-----|-----| NA
   (never)   (2 times/   (4 or more
                          month)   times/month)

7. I forgot to pick up items I needed when shopping (during the last week).
   |-----|-----|-----|-----|-----|-----|-----|-----| NA
   (never)   (2 times/wk   (4 or more/wk

8. I forgot to meet a friend on time (during the last week).

    |-----|-----|-----|-----|-----|-----|-----|-----| NA

    (never)   (2 times/   (4 or more
                       week)   times/week)

9. I forgot to pass on a message to someone (during the last week).

    |-----|-----|-----|-----|-----|-----|-----|-----| NA

    (never)   (2 times/   (4 or more
                       week)   times/week)

10. I forgot to run an errand I meant to do (during the last week).

    |-----|-----|-----|-----|-----|-----|-----|-----| NA

    (never)   (3 times/   (6 or more
                       week)   times/week)

11. I forgot to return a phone call (during the last week).

    |-----|-----|-----|-----|-----|-----|-----|-----| NA

    (never)   (2 times/   (4 or more
                       week)   times/week)

12. I forgot to make an appointment I needed to make (e.g., doctor or dentist)
    (during the last month).

    |-----|-----|-----|-----|-----|-----|-----|-----| NA

    (never)   (2 times/   (4 or more
                       month)   times/month)

13. I forgot to write an important letter ((during the last month).

    |-----|-----|-----|-----|-----|-----|-----|-----| NA

    (never)   (2 times/   (4 or more
                       month)   times/month)

14. I forgot to return books to the library by the due date (during the last month).

    |-----|-----|-----|-----|-----|-----|-----|-----| NA

    (never)   (2 times/   (4 or more
                       month)   times/month)

15. I forgot to tip when I finished dinner at a restaurant (during the last month).

    |-----|-----|-----|-----|-----|-----|-----|-----| NA

    (never)   (2 times/   (4 or more
                       month)   times/month)

16. I forgot to turn my alarm clock off when I got up in the morning (during the
    last week).

    |-----|-----|-----|-----|-----|-----|-----|-----| NA

    (never)   (2 times/   (4 or more
                       week)   times/week)

17. I forgot to lock the door when leaving my apartment or house (during the last
    week).

    |-----|-----|-----|-----|-----|-----|-----|-----| NA

    (never)   (2 times/   (4 or more
                       week)   times/week)

18. I forgot to take my keys out to my car before locking the doors (during the
    last month).

    |-----|-----|-----|-----|-----|-----|-----|-----| NA

    (never)   (2 times/   (4 or more
                       month)   times/month)

19. I forgot to button or zip some part of my clothing as I was dressing (during
    the last week).

    |-----|-----|-----|-----|-----|-----|-----|-----| NA

    (never)   (2 times/   (4 or more
                       week)   times/week)

20. I forgot to pay the bill when finishing a meal at a restaurant (during the last month).

|-----|-----|-----|-----|-----|-----|-----|-----| NA

(never)   (2 times/   (4 or more/mth)

21. I forgot to put a stamp on a letter before mailing it (during the last month).

|-----|-----|-----|-----|-----|-----|-----|-----| NA

(never)   (2 times/   (4 or more
                  month)   times/month)

22. I forgot to comb my hair in the morning (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA

(never)   (2 times/   (4 or more
                  week)   times/week)

23. I forgot to put on deodorant after showering or bathing (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA

(never)   (2 times/   (4 or more
                  week)   times/week)

24. I forgot to flush the toilet (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA

(never)   (2 times/   (4 or more
                  week)   times/week)

25. I forgot to get the groceries out of the car when I got home from the grocery store (during the last month).

|-----|-----|-----|-----|-----|-----|-----|-----| NA

(never)   (2 times/   (4 or more
                  month)   times/month)

26. I forgot to lock up my house, bike, or car (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA

(never)   (2 times/   (4 or more
                  week)   times/week)

27. I forgot to shower or bathe (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA

(never)   (2 times/   (4 or more
                  week)   times/week)

28. I forgot to cash or deposit my paycheque before my account ran out of money (during the last month).

|-----|-----|-----|-----|-----|-----|-----|-----| NA

(never)   (2 times/   (4 or more
                  month)   times/month)

29. I forgot what I wanted to say in the middle of a sentence (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA

(never)   (2 times/   (4 or more
                  week)   times/week)

30. I forgot to say something important I had in mind at the beginning of a conversation (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA

(never)   (2 times/   (4 or more
                  week)   times/week)

31. I forgot what I came into a room to get (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA

(never)   (2 times/   (4 or more
                  week)   times/week)

32. I started to do something, and then forgot what it was I wanted to do (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
                week)   times/week)

33. I forgot to bring something I meant to take with me when leaving the house (during the last month).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
               month)   times/month)

34. I got part way through a chore and forgot to finish it (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
                week)   times/week)

35. I was driving and temporarily forgot where I was going (during the last month).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
               month)   times/month)

36. I dialled someone on the phone and forgot who I had called by the time they answered (during the last month).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
               month)   times/month)

37. I started writing a note or letter and forgot what I wanted to say (during the last month).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
               month)   times/month)

38. I started to write a cheque and forgot to whom it was to be paid (during the last month).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
               month)   times/month)

39. I make lists of things I need to do (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
                week)   times/week)

40. I write myself reminder notes (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
                week)   times/week)

41. I make a grocery list whenever I go shopping for food (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
                week)   times/week)

42. I plan daily schedule in advance so I will not forget things (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
                week)   times/week)

43. I repeat things I need to do several times to myself in order to remember (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
                      week)   times/week)

44. I use external reminders like tying a string around my finger to help me remember to do things (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/ wk)   (4 or more times/wk)

45. I rehearse things in my mind so I will not forget to do them (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
                      week)   times/week)

46. I lay things I need to take with me by the door so I will not forget them (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
                      week)   times/week)

47. I make post-it (sticky notes) reminders and place them in obvious places (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
                      week)   times/week)

48. I create mental pictures to help me remember to do something (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
                      week)   times/week)

49. I put things in piles so I know which ones to do first and which can wait (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
                      week)   times/week)

50. I lay in bed at night and think of things I need to do the next day so I won't forget to do them (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
                      week)   times/week)

51. I try to do things at a regular time so I will remember to do them (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
                      week)   times/week)

52. I keep an appointment book updated in order to remember to do things (during the last week).

|-----|-----|-----|-----|-----|-----|-----|-----| NA
(never)   (2 times/   (4 or more
                      week)   times/week)

APPENDIX 3:

The 21 location-action combinations used for the PRVP task, taken from the Forster 2003 study.

LOCATION	ACTION/MEMORY
Halifax	Has loan cheque cleared?
1st man pushing pushchair	Use mobile to text
Woman on bench with dog	Ask her the time
Dixons	How much PlayStation2
Girl sitting with dog	Colour of jacket of woman petting dog?
H Samuels	Get watch battery
W H Smiths	Ask if any job available
HMV	Buy album
BurgerKing	Buy Milkshake
Flower Stall	What colour is stall's roof?
Wallis	How many Phone Boxes?
Thorntons	Buy bag of toffees
The Orange shop	Buy a £10 top-up card
Boots Store	What's boy wearing on face?
Mobile phone stall	Ask directions to station
The Link	Instrument man is playing?
Man asking for change	Check pocket for 20p
Picture Stall	Who is the famous bear?
At Clinton Cards	Note what event they are celebrating (Halloween)
When you encounter a woman saying 'nice day today'	Ask her if her mother is keeping well
At Woolworths	Note what the boys are doing (playing)

APPENDIX 4:

The 15 location-action combinations used for the RWPMT task, developed in-house for the PhD.

LOCATION	ACTION/ITEM
At the University Shop In Ellison	Ask 'Do You Sell Sandwiches?'
At the Business School Entrance	Ask 'Is Coach Lane Near Hear?'
At the Career Services	Ask what the opening hours are
At the Students Union	Ask 'When Is The Next Gig?'
When you reach Lipman Building Café	Ask about a part-time job
At the Art Gallery	Ask if they have a 'Lowry'
When you reach the City Hall	Find out when the next graduation is
At the Library	Remember to check the messages on your mobile phone
At Rutherford Hall	Ask where the nearest telephone is located
At the Sports Centre	Check the cost of a membership
At the 'Well Read' Bookshop	Ask for directions to the Metro
When you reach 'Trinity Building'	Check if there is a Canteen nearby
At the shop called 'Londis'	Purchase a £10 Top Up For Mobile Phone
At the Car Park	Find out the time
When you reach the Book Statue	Ask 'Where can I hire a car?'

APPENDIX 5:

The 16 location-action combinations used for the PRVP task, taken from the Jardine 2002 study.

Location	Action/Memory
When you reach store 'Beaverbrook's	Ask if your watch has been fixed
At the stall selling plants	Ask directions to City Baths
As you pass Burger King	Ask about their promotional offer
When you pass the HMV store	Check phone messages
At the Metro Station	Find out when last train to the coast
When you see the Band Playing	Note how many are in band
At the Dixons store	Remember to check cost of a TV
When you reach the Virgin Store	Ask about credit for purchases
When you reach the Fruit Stall	Ask for change of a £5
When you reach the store 'Body Shop'	Ask about any job vacancies
When see the man with an orange /red jacket talking to a woman	Remember to text a friend
When you pass a Telephone Boxes	Count how many there are
When you reach the store 'Next'	Exchange the jumper you bought
When you see the Pigeons	Remember to feed them
When you reach 'WH Smiths'	Top up your mobile phone
When you reach the store selling Christmas paper	How much for 20 sheets?

APPENDIX 6:

The 12 location-action combinations and three extra items used for the RWPMT task, developed in-house for the PhD.

LOCATION   **ACTION/ITEM**

At the 'Habita' Bar
remember to: 1) Look on menu for the cost of a Pizza
                   2) Ask if they sell cigars
                   3) Ask when next football match is being shown on TV
                   4) Ask for directions to nearest Metro station.

In the library
remember to: 1) Check that the book by Heffernan is available
                   2) Ask where the smoking area is located
                   3) Check your library account
                   4) Text a friend.

In the shop
remember to: 1) Buy a packet of Marlboro cigarettes
                   2) Ask the time
                   3) Purchase a top-up card for phone
                   4) Ask where the nearest cash machine is located.

In addition, 3 more actions required:

1. Prior to the tour, a note will be placed in the researcher's inside pocket and must be drawn to the attention of the researcher at the end of the testing session.

2. Contact the researcher by e-mail during the next day.

3. Provide details of their ID code.