The effects of acute exercise on short term smoking withdrawal symptoms and desire to smoke

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ABSTRACT

The aim of this thesis is to investigate the effect of physical activity on smoking withdrawal symptoms and desire to smoke in acutely abstinent, sedentary smokers. Previous research has reported physical activity and exercise to be effective at reducing common smoking withdrawal symptoms and desire to smoke in long term smokers. Little is actually known however about the mechanisms underlying this phenomenon, and previous research has produced some negative results particularly when high intensity exercise has been performed. In order to address these issues a series of four experiments were conducted. It was found that light intensity exercise of 5 minutes duration produces only small reductions in withdrawal, while 10 minutes of moderate intensity exercise is effective at reducing withdrawal symptoms and desire to smoke in sedentary smokers. This effect was transient however, as the reductions appeared to last only approximately 10 minutes after exercise was terminated. Distraction, exercise related changes in affect and expectation of exercise effects on withdrawal appear to be unrelated to these reductions, hence a purely psychological mechanism by which this effect occurs was not found. Analysis of smokers’ motivation to smoke also suggests that all smokers may benefit from using exercise to reduce withdrawal symptomology. The limitations within this research are discussed, and possible avenues of further research are put forward.
ACKNOWLEDGEMENTS

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CHAPTER ONE

SMOKING: EFFECTS ON HEALTH, PHYSIOLOGICAL AND
PSYCHOLOGICAL IMPLICATIONS OF WITHDRAWAL, AND CURRENT
APPROACHES TO SMOKING CESSATION

1.1 INTRODUCTION

There are a number of important issues that require exploration in order to conduct smoking related research. Some of these include issues such as the prevalence of smoking, the distribution of smokers in a socio-economic context and the consequences, both in a psychological and physiological sense, of nicotine addiction. By exploring these issues a better understanding of what exactly is required of smoking cessation methods will be acquired, which in turn may guide research into smoking behaviour. The focus of this thesis concerns the effect of acute exercise on common smoking withdrawal symptoms and desire to smoke. Smoking and exercise research is both theoretically interesting and also has potential practical implications, implications that could have major psychological, physiological and economic benefits for smokers. The subsequent chapters will provide detailed empirical accounts of experimental research carried out, investigating a number of issues integral to the exercise and smoking relationship. However before any of this can begin a basic understanding of a number of different areas in smoking research has to be attained.

1.2 SMOKING

A significant percentage of the UK population still smoke. The Department of Health statistical bulletin (2000) states in 1998 27 per-cent of adults aged 16 and over smoked cigarettes on a regular basis (28 per-cent of men and 26 per-cent of women). Compared to figures of prevalence of cigarette smoking in 1978 the number of adults smoking has dropped substantially, from approximately 40% to the figures reported today. The most recent figures from the National statistics office (2002) state that 24
per-cent of women and 26 per-cent of men smoke, with an overall figure of 25% of the population smoking in the UK in 2002. This figure has not changed significantly since 1996, with figures averaging 26 per-cent in terms of total smokers in the UK population over the past six years. These percentages are derived from the general household survey (GHS), which research has suggested provides an accurate view of prevalence of smoking in the UK (Jarvis, 2003). Jarvis reports that since 1999 smoking has declined by approximately 0.4% per year and that the target figure of 26% of the UK population smoking by 2005 (set by the Smoking Kills white paper, 1998) may have already been reached. Jarvis accounts for this decline in smoking since 1978 via effective government strategy from the 1990’s onwards of a comprehensive number of measures to decrease overall smoking in the UK. These include rises in cigarette prices above inflation, a blanket tobacco advertising ban and the development of a network of smoking cessation treatment services.

In terms of socio-economic classification the prevalence of smoking is higher for people in manual, compared to non-manual, socio-economic status groups (SES). Marsh and Mckay (1994) found after an extensive review of evidence relating to smoking and SES status that low income families are more likely to smoke than higher income families, and by a much larger margin. Less than a quarter of the highest income group were found to smoke. This has also been found elsewhere (Barbeau, Krieger & Soobader, 2004). An important characteristic of this body of smokers is that of all smokers who completed the 2002 national household survey, 70% reported that they wanted to give up smoking. This is an extraordinarily high figure when considering cessation uptake and rates of cessation success (which is approximately 15% long-term smoking abstinence).

Every year around 114,000 deaths are linked to smoking in the UK (Petersen & Peto, 2004). The government spends approximately 37 million pounds on smoking education and cessation services, with an estimated cost to the NHS of around 1.5 billion pounds per year due to smoking related illnesses. These figures starkly illustrate that the issue of smoking is still of national importance. As such continued in-depth investigation into smoking behaviour is required in order to generate
knowledge that will enable new, and more effective ways, of changing smoking behaviour.

When comparing the UK with other nations, the demographic and social distribution of smokers is very similar. For example in the United States around 23.4% of the population smoke, with over 40% of these smokers trying to stop smoking at least once a year (National Centre for Chronic Disease Prevention and Health Promotion, 2004). In 2000 the lowest overall percentage of the population smoking was 19% in Sweden and the highest was 37% in Germany and Greece (General Household Survey, 2002). The majority of these smokers are placed within the lowest SES groups, as has been found to be the case in the UK. It is clear that smoking is a global problem and that some cultural differences may exist in terms of numbers of smokers. Why these differences exist is unclear and further investigation is required to investigate cultural specific differences in smoking behaviour.

1.2.1 Physiological effects of smoking on health

It was established as early as 1951 (Doll), and supported by a wealth of other research, how detrimental to health smoking can be. Doll, Peto, Wheatley, Gray and Sutherland (1994) followed up, and supported, their seminal work on cancer rates in GP's who smoked by demonstrating that there was a causal link between chronic smoking and cancer. Smoking was also linked to other conditions such as respiratory disease and cardiovascular problems. In general, smokers endure poorer health than non-smokers, and it is estimated that the average smoker looses around 23 years of life due to a life long smoking habit (Doll & Peto, 1983). In 'The Causes of Cancer' (1983) Doll and Peto state that the only cause of cancer whose effects are both large and reliably known is tobacco, which in 1981 accounted for approximately 140,000 cancer deaths in the USA.

The number of diseases that smokers more commonly acquire and are more prone to are numerous. These include respiratory disease, cardiovascular disease (CHD), cancer of the throat, lung, mouth, liver and numerous other cancer sites (Levy & Martin, 1989). The nicotine component of smoking has also been directly linked to
acute ischemic events in people with CHD (Benowitz, 1991). Smoking has been found to be related to reduced grey matter within the brain, as well as reduced density in areas of the brain associated with cognition (Brody, Mandelkern, Jarvik, Lee, Smith et al, 2004). Suffice to say that world-wide, about 4 million people are thought to die prematurely each year as a result of smoking, which is estimated to rise to 10 million a year by 2030 (http://www.ash.co.uk, 2004). Although smoking in western countries, such as in the UK, may be decreasing smoking rates in Africa and third world countries are increasing, hence the estimated increase in smoking related cancer deaths over the next 30 years.

Despite these negative associations research has shown that smokers continue to smoke even after suffering a heart attack (Burt, Illingworth, Shaw, et al, 1974), after undergoing a laryngectomy (Himbury & West, 1985) and following lung cancer surgery (Davison & Duffy, 1982). Research specifically investigating smoking cessation interventions delivered to smokers admitted to hospital with cardiac problems found that those smokers who had bypass surgery were twice as likely to go back to smoking, compared to those who had a myocardial infarction (Hajek, Taylor & Mills, 2002). Extensive evidence has also shown that smoking during pregnancy can lead to increased risk of low birth rate, cot death and learning and behavioural problems in children (Floyd, Rimer, Guiovino et al, 1993; Milberger, Biederman, Faraone & Jones, 1998). Despite these health risks of smoking during pregnancy, interventions specifically designed for pregnant smokers often report low cessation figures and brief interventions during pregnancy have found only 24% of recent ex-smokers and 3% of current smokers remain abstinent 6 months after birth (Hajek, West, Lee, Foulds, Owen et al, 2001).

This research illustrates the negative impact smoking has on health and how long term smoking can lead to premature death and increased prevalence of numerous chronic illnesses. It also starkly demonstrates the difficulty smokers have in quitting and the persistence of addiction to smoking. There appears to be an almost juxtaposed relationship between a smoker’s behaviour and what the habit actually does to the smoker’s body. It remains a major challenge within contemporary Health
Psychology to determine an effective way to change such negative health behaviours using psychological methods.

1.2.2 The physiological effects of nicotine

Nicotine is the substance in cigarettes that is believed to cause addiction. Nicotine is absorbed via cigarette smoke, much of which is lost via a number of different mechanisms, length and depth of inhalation for example. Nicotine is readily absorbed into the bloodstream and rapidly crosses the blood brain barrier. It is estimated that this transfer takes as little time as 7 seconds, hence the almost immediate effects of smoking on the brain. Nicotine is active at a large number of Acetylcholine (Ach) receptors throughout the body (in parts of the central nervous system for example), these are widely known as nicotine receptors (Royal Pharmaceutical Society, 1996). Nicotine first stimulates, then blocks, these receptors, which may be a factor in the sometimes-contradictory effects reported by smokers (for example the stress relieving effect of smoking many smokers report, despite the pharmacological action of nicotine actually having stimulant effects on the brain).

Smoking is irrevocably linked to addiction and as such it is important to understand how smoking becomes addictive. The sites for addiction of any substance are believed to originate within the brain, and it is on the brain that nicotine exerts its influence. However, this process is far from clear, and it is beyond the scope and remit of this thesis to fully explore these mechanisms and processes. Suffice to say a more general view of addiction and its action will be adopted for the purpose of this research.

It is generally held that nicotine is the primary addictive agent of smoking. The fact that tobacco is only ever consumed in ways that permit pharmacological absorption of nicotine is in itself circumstantial evidence that points to nicotine being the addictive agent in cigarettes (Jarvis, 2004). Absorption of nicotine occurs via the lungs in the case of inhaled smoke, through the nasal mucosa with snuff, and via buccal mucosa with non-inhaled smoking of cigars and pipes. Self-administration of nicotine in animals has shown that intermediate doses of nicotine and cocaine are
comparable in terms of how the animals respond to the drug (Goldberg, Spielman & Goldberg, 1981; Spielman & Goldberg, 1982). Goldberg and colleagues also found that under certain conditions nicotine injection led to dose related suppression of behaviour.

In addition to these biological effects nicotine also appears to influence brain chemistry, specifically neurotransmitters (serotonin and dopamine for example; Benwell, 1992). This is an important factor in nicotine addiction as dopamine stimulates the brain’s pleasure centres, and serotonin plays a major role in the control of mood. The pertinent issue here is how nicotine, the primary addictive constituent of tobacco, interacts with the body and what this illustrates about smoking addiction. The physiological and some of the behavioural effects of nicotine in humans are summarised in Table 1.1. These effects can occur by actions on the central nervous system itself, either directly or via peripheral chemoreceptors, by actions on the peripheral nervous system, release of catecholamines (hormones) from neurones and/or facilitation of neurotransmitter release (Armitage, 1965, 1973). Although not exhaustive, it is felt these are some of the most important effects of nicotine in humans.

Table 1.1: Action of nicotine in humans

<table>
<thead>
<tr>
<th>Cardiovascular</th>
<th>Central Nervous system</th>
<th>Metabolic</th>
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<tbody>
<tr>
<td>Increased heart rate</td>
<td>EEG changes</td>
<td>Increased free fatty acids</td>
</tr>
<tr>
<td>Cardiac contractility</td>
<td>Tremor</td>
<td></td>
</tr>
<tr>
<td>Increased Blood pressure</td>
<td>Arousal or relaxation</td>
<td></td>
</tr>
<tr>
<td>Cutaneous vasoconstriction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(decreased skin temperature)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catecholamine release</td>
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Researchers have attempted to elucidate these biochemical mechanisms. Pomerleau and Pomerleau (1984) investigated neuroregulators and reinforcement of smoking behaviour. They concluded that due to the rapid action of nicotine and its diverse effect on neurological systems, it is a particularly effective ‘coping response’ to the demands of life. They concluded that there is a bi-phasic pattern of arousal/alertness during smoking followed by a calming/tension reduction after smoking. The authors
postulate this may result from cholinergic and catecholaminergic activation followed by cholinergic blockade or beta-endorphin release. They further postulate that pleasure due to smoking may be linked to dopamine and norepinephrine release and relief from nicotine withdrawal with release of acetylcholine. The research does suggest a strong link between neural changes due to smoking and following behavioural responses. New brain imaging techniques which allow rapid assessment of cerebral blood flow may allow for identification of the mood-altering properties of nicotine as well as the brain regions important in nicotine withdrawal (London, 1994).

1.1.3 Tolerance to Nicotine

A crucial aspect of smoking behaviour is the withdrawal symptoms smokers experience when they cease smoking. These symptoms would not occur if nicotine tolerance did not develop. Tolerance to many of the effects of nicotine develops rapidly, including toleration to dizziness, nausea and subjective stimulant actions of the first experience of smoking. This tolerance does however depend on amount of nicotine, the duration of exposure to a given level and the rate of nicotine absorption within a particular area of the brain. The time course of disappearance of tolerance may be an important determinant of individual smoking withdrawal patterns (Marks, Stizel & Collins, 1985). After overnight abstinence people regain sensitivity to some of the effects of nicotine, such as arousal and heart rate acceleration. In animals Marks, Stitzel and Collins (1985) found that maximal tolerance to nicotine was found after 4 days of nicotine administration. Tolerance to nicotine was lost after 8 days once nicotine administration ceased. In brief it is reasonably clear that chronic nicotine exposure is associated with substantial central nervous system adaptation, including changes in receptor and neurotransmitter systems. The consequence of this adaptation is the development of abstinence symptoms during nicotine withdrawal.

A distinction that needs to be clear in terms of this thesis is, is the research primarily interested in nicotine addiction or addiction to smoking in a more general sense? It is undoubtedly difficult to separate nicotine from smoking behaviour but it is possible to test the effects of nicotine alone. However, the act of inhaling from a cigarette and
all that goes with this behaviour is arguably just as important as nicotine itself (West, 1987). Hence it is important to make the distinction that what is being investigated within this thesis is smoking and smoking withdrawal, rather than just addiction to nicotine. Although nicotine itself is an intrinsic part of smoking and smoking behaviour, it is the whole behavioural process of smoking that is of primary interest here.

1.3 ADDICTION TO SMOKING AND ‘CRAVING’

Addiction itself is much more than just a physiological consequence of smoking. It is a complex issue that requires in-depth investigation if true understanding of drug addiction is to be achieved. Some researchers argue smoking has a number of adaptive functions for smokers, as well as negative consequences. Warburton (1989) states that smoking is a purposeful activity for smokers, providing them with nicotine as a resource for managing their lives and giving them control of their psychological state. There is indeed some evidence to support this view. Research has suggested that smokers feel more relaxed and calmer and in a better mood in general, when smoking (Mangan & Golding, 1978). Warburton does acknowledge that some of the beneficial effects of smoking are associated with the addictive features of nicotine use (Warburton, 1989). Many researchers reviewing evidence in this area have concluded it is evidently clear that smoking behaviour is exceedingly resistant to change (Jarvik, 1973).

Addiction to smoking has been defined as a behaviour over which an individual has impaired control, which can have harmful consequences (West, 2001). West goes on to argue that most smokers recognise that their behaviour is potentially harming them or those around them, yet they find themselves unable to stop even when attempting to do so. Smoking has persistently proved to be difficult to stop, despite a majority of current smokers wishing to stop. In 2003 78% of all smokers who attempted to quit in that year, failed to do so in the long-term (Department of Health, 2000; Office for National Statistics, 2003). This violates the smoker’s free choice and therefore is considered by some as a motivational psychiatric disorder (West, 2001).
Another issue of importance, that is fundamentally related to smoking addiction, is the concept of 'craving'. It is arguably craving that is the most pertinent feature of addiction, and the presence of it has led researchers to overwhelmingly conclude that smoking is a habit with strong addictive characteristics. The presence of nicotine within the blood has been found to be strongly associated with craving for cigarettes, with deprivation of 16 hours resulting in low nicotine levels in the blood and high craving to smoke (Jarvik, Madsen, Olmstead, Iwamoto-Shaan, Elins, et al., 2000). A potential problem with these findings and with a large amount of research in this area, is exactly how one conceptualises craving for cigarettes. Gilbert and Warburton (2000), as well as others (West & Kranzler, 1990; Wise, 1988), point out that there has been little agreement amongst researchers in this area as to what the precise meaning of 'craving' is. Kozolowski and Wilkinson (1987a; 1987b) argue that the term craving should only be used as a technical term to describe a 'strong desire to smoke'. They argue that craving refers to a very strong, intense desire, and that using it to refer to all urges to smoke, both very strong and light, is too vague to be useful. There is also evidence to suggest that the term craving is understood differently in drug users compared to common usage of the term and its dictionary definition (Kozolowski, Mann, Wilkinson & Poulos, 1989).

In order to avoid this problematic issue, this research will not use the term craving due to the terms semantic ambiguity. In measures used within research presented here the term craving will be replaced with desire to smoke, or strength of desire for a cigarette, in order to attempt to provide a clearer understanding amongst participants what measures are exactly referring to. Gilbert and Warburton (2000) argue that only one question is required to determine if a participant wants to use a particular drug, and as such research in the areas of smoking, and exercise and smoking (Ussher, Nunziata, Copley & West, 2001; West & Russell, 1985) have used single item measures to determine smoking urges and desire for cigarettes successfully. As such this is the approach that will adopted within this thesis.
1.3.1 Physiological effects of smoking abstinence

For ease of exposition a distinction will be made here between the physiological and the psychological effects of smoking withdrawal. The prevailing view of drug dependence suggests that regular exposure to certain substances i.e. psychoactive drugs, can lead to neuroadaptations which in turn set in motion a cycle of escalating tolerance and increased self-administration, until a form of stasis or collapse is reached (from Pomerleau, Collins, Shiffman & Pomerleau, 1993). Interruption of this cycle causes a disequilibrium, which results in the characteristic signs and symptoms of withdrawal. Much of the research into smoking withdrawal and its physiological effects has predominantly used controlled doses of nicotine in order to determine abstinence effects. As no direct investigation of nicotine alone will be undertaken here, addiction to smoking as a behaviour will be investigated rather than just nicotine addiction per se. Nevertheless, as nicotine is a fundamental component of smoking research investigating the effects of nicotine alone, in isolation from smoking behaviour, will be reviewed here briefly.

Many studies conducted investigating the physiological effects of nicotine have used animals as study participants. For example, Corrigal, Herling, and Cohen (1989) administered nicotine to rats over a ten-week period then abruptly ceased administration. It was found that rats deprived of nicotine showed behavioural deficits after nicotine was withdrawn, for example they showed less motor activity and reduced social behaviours. The authors concluded that this was comparable to humans withdrawing from nicotine use. Caroll, Lac, Asencio and Keenan (1989) found that after administration of nicotine to rats subsequent withdrawal of nicotine resulted in disruption of reinforced behaviour patterns. Re-administration of nicotine after withdrawal resulted in behaviour returning to that seen during the first period of nicotine administration. Although perhaps not directly comparable to humans these findings do illustrate the behaviour disruption that is possible after nicotine withdrawal. In terms of mechanisms responsible for these effects Miyata and Yanagita (2001) suggested that withdrawal is at least partly due to desensitisation of the reward system in the brain, due to chronic nicotine use. They also suggest that endocrine system disturbances may be related to withdrawal.
Investigations into smoking and electroencephalographic (EEG) effects predominantly conclude smoking a preferred brand cigarette results in a stimulant-like EEG profile (Knott, 2001). For example, Herning, Jones and Bachman (1983) found decrements in EEG activity after smoking cessation. After relatively short periods of cessation (10-17hrs of smoking deprivation) theta and to a lesser extent alpha wave power were decreased. Ulett and Itil (1969) compared EEG profiles of young, heavy smokers when they had been smoking normally and after 24 hours of deprivation. Compared to their EEG recordings whilst smoking, deprivation was found to produce significant increases in slow frequency wave lengths (theta and delta waves). Resuming smoking was found to reverse these effects. Ulett and Itil’s methodology also included comparing behavioural aspects of smoking as well as actually smoking cigarettes. The methodology employed a condition in which participants smoked a sham cigarette during smoking abstinence whilst EEG was recorded. Some of the EEG effects of smoking were seen in this sham smoking condition, which seems to suggest that smoking withdrawal and smoking as addiction, is more than the effects of nicotine alone. The act of smoking may also be important in this relationship. The effects of smoking on EEG profile have been found to be reasonably consistent (Domino, Riskalla, Zhang & Kim, 1992; Xu & Domino, 2000). Overall EEG research investigating smoking withdrawal shows that brain activity appears to slow down, with smoking directly counteracting these effects.

Using different brain imaging techniques other researchers have investigated the effects of smoking on the brain. Brody, Mandelkern, London, Childress, Lee et al (2002) conducted a neuropsychological study examining brain activation in heavily addicted smokers. Brody et al found that when participants were abstinent for 30 minutes and after looking at cigarette cues via video, a number of areas of the brain were activated (measured by Positron Ommision Tomography (PET) and Magnetic Resonance Imaging (MRI) scans). They found that the anterior cingulate gyrus (AC), left anterior lobe and the orbitofrontal cortex (OFC) were activated during smoking. Also subjective measures of desire to smoke were also recorded before, during and after these scans. It was found that subjective cigarette cravings were positively correlated with activation in bilateral OFC, dorsolateral prefrontal cortex (DLPC)
and interior insula metabolism. Previous studies (Breslau, 1995; Black, Zimmerman & Coryell, 1999; Lasser, Boyd, Woolhandler, et al, 2000) have reported very similar areas of activation in cocaine, alcohol and other types of addiction, as well as mood and anxiety disorders. This suggests that addiction and withdrawal in general are related to these same neurological structures, whether it be addiction to nicotine, alcohol or any other psychoactive, addictive substance.

Overall there is a wealth of evidence to suggest that smoking effects bio-chemistry, brain activation and neuro-electrical activity. The fact that smoking activates areas of the brain associated with addiction to other substances, as well as nicotine, suggests a generality about the biological effects of addiction. Specifically, in terms of smoking EGG studies, evidence has shown a reasonably consistent view of what happens when smoking and when withdrawing from long-term nicotine use. It may well be the case that producing a cessation technique that has these effects may be effective at reducing withdrawal.

1.3.2 Psychological effects of nicotine withdrawal

Smoking withdrawal attracts huge amounts of research, and it is beyond the scope of this thesis to provide a detailed explanation of every facet of the smoking withdrawal syndrome. It is important to note the semantic differences between ‘desire to smoke’ and ‘smoking withdrawal symptoms’, the latter refers to mood disturbance, i.e. anxiety, difficulty concentrating etc whereas the former refers to a specific desire or urge to smoke. These are the main and arguably the most important features of withdrawal from smoking (West & Schneider, 1987). The Diagnostic and Statistical Manual Classification of Mental and Psychiatric Disorders (DSM-IV, 2000) includes nicotine addiction as a substance abuse disorder. It describes nicotine withdrawal by a number of specific criteria, specifically that the smoker, within 24 hours of abruptly reducing nicotine intake, develops 4 or more of the following listed symptoms. These include dysphoria or depression, insomnia, anger, frustration or irritability, anxiety, trouble concentrating, restlessness, slowed heart rate and increased appetite or weight. The criteria also add that these symptoms can cause clinically important distress and impair work, social or personal functioning. This is how withdrawal is
Withdrawal from nicotine use produces psychological symptoms in smokers who are attempting to quit. This is now believed to be immutable fact, supported by a wealth of research that has shown mood disturbances in smokers who attempt abstinence (for example Heimstra, 1978; Munafo, Drury, Wakley, Chambers & Murphy, 2003). However smoking withdrawal is a complex and intricate set of behaviours that are problematic to investigate. It is primarily this withdrawal that is the target for the majority of current smoking cessation aids. Hence for this reason alone, aside from scientific and intellectual interest, it is important that the phenomenon of withdrawal is understood, and specifically what challenges and limitations this places on current and potentially new cessation techniques.

Piascecki, Fiore and Baker (1998) conducted research investigating the differences abstinent smokers report in terms of withdrawal symptoms. From analysis of three ‘clusters’ of withdrawal patterns, Piascecki et al reported that the following symptoms were the most common amongst participants: urge/desire to smoke, irritability, difficulty concentrating, anxiety, depression/dysphoria, impatience, sleep disturbance and hunger. These were reported to be most severe in the first week of abstinence, then they steadily decrease over the preceding month. Results from statistical analysis bore out the following conclusions: that some participants exhibited abstinence-contingent withdrawal, and this pattern resembled that commonly described in the literature (i.e. brief, initial increase followed by steady amelioration over time). Severity of symptoms was greater over the first 2 weeks of abstinence, and withdrawal patterns (i.e. stress, anxiety, depression) worsened or remained high outside the post-cessation period. Also it was found that those abstainers with worsening or unremitting symptoms were more likely to relapse than participants who showed prototypical patterns of withdrawal. This is direct evidence of the importance of withdrawal and its association with cessation success. Importantly atypical withdrawal patterns were found in 39% of participants indicating the large variation in withdrawal experienced by smokers, conclusions supported by other research (see Piascecki, Niaura, Shandel, Abrahms, Goldstein et
al, 2000). Again ‘atypical’ withdrawal was found to be common, characterized by peaks and unremitting symptoms. Participants who exhibited these withdrawal patterns were also found to be more likely to relapse.

Tate, Pomerleau and Pomerleau (1993) attempted to investigate the temporal stability and within-subject consistency of nicotine withdrawal symptoms. Tate and colleagues found that common withdrawal symptoms measured in their study (irritability, decreased heart rate, anxiety, desire to smoke and difficulty concentrating) emerged as stable symptoms of smoking withdrawal. Tate et al, however, go on to remark that the nature and severity of withdrawal differed from participant to participant and from one abstinence period compared to another. For example, within the sample, 21% of participants reported less symptoms during abstinence periods compared to baseline. And 18% of participants reported greater than baseline desire to smoke at one abstinence period and less than baseline symptoms at another period. Tate et al suggested two possible explanations for these inconsistencies. Firstly it was suggested that the withdrawal experience may differ from one abstinence period to another due to setting, expectancies and method of cessation. Secondly, that there may be subtypes of smokers who experience withdrawal differentially, specifically that there is a difference between smokers in respect to the spectrum of symptoms that they report during smoking abstinence.

These findings have been reported in numerous other studies. For example Shiffman and Jarvick (1976) attempted to determine common withdrawal and desire to smoke effects in abstinent smokers. They measured various common withdrawal symptoms in smokers, including desire to smoke, tremor, insomnia, anxiety and difficulty concentrating. The authors found that symptoms reported by participants were grouped into four areas, namely stimulation, desire to smoke, physical withdrawal symptoms and psychological withdrawal symptoms. Although Shiffman and Jarvick reported some common withdrawal effects, there was a large degree of variation within the sample, and within the symptom categories. This may make it questionable if there is a reliable common withdrawal syndrome at all and if what symptoms that do occur can be measured with any degree of reliability. In an attempt to answer this type of issue Hughes and Hatsukami (1984, 1994) tested the validity
and magnitude of the signs and symptoms of nicotine withdrawal by measuring various common withdrawal symptoms in 50 smokers during two days of smoking and then the first 4 days of abstinence. They found that all of the DSM-III ratings of tobacco withdrawal increased significantly during the abstinence period, these included desire for tobacco, irritability, anxiety, difficulty concentrating, and restlessness. However the authors also noted that the intensity and variety of withdrawal symptoms varied greatly across participants. A number of factors were proposed for why this might be the case, including degree of dependence on smoking and a priori expectations or ‘abstinence phobias’.

In a review of abstinence literature Hughes and Hatsukami (1984) reported numerous studies in which the same symptoms were continually found directly after tobacco abstinence in regular smokers, i.e. anger, irritability, anxiety, impatience, restlessness, depression, difficulty concentrating, and impaired performance. Research has also supported the notion that many of the symptoms experienced after smoking cessation are due to nicotine deprivation, for example these symptoms are relieved by nicotine gum and other nicotine replacement products, and they still occur upon cessation of smokeless tobacco (Hatsukami, Gust & Keenan, 1987). Also they can be gradually reduced via reductions in number of cigarettes smoked (Hughes et al, 1990). This is not say, however, that all researchers are in agreement about the natures of withdrawal. Hughes and Hatsukami (1984) point out that within withdrawal research there are a number of unresolved, or contentious issues. Important issues are the poor consensus within research on how to define ‘craving’, some research has failed to show that during abstinence symptoms increase over pre-cessation levels and desire to smoke levels have been reported to be high when smokers are still smoking (Hughes 1987). There has also been some debate as to whether certain symptoms of withdrawal are not really just offset effects of ceasing nicotine use. West and Hajek (1997) for example suggest that increased anxiety may not be a central element of withdrawal.

Also exploring the phenomenon of smoking withdrawal Willner, Hardman and Eaton (1995) evaluated cigarette symptoms after abstinence. They found that smoking deprivation of between 4-14 hours slightly decreased positive mood but significantly
increased negative mood and both of these changes were completely reversed by
smoking. They note that this change could be brought about with just seven to eight
puffs on a cigarette, perhaps reflecting the very rapid uptake of smoked nicotine by
the brain (Benowitz, Porchet & Jacob, 1990). One issue that has not been addressed
so far is the possibility that smokers may not experience ‘normal’ mood whilst
smoking. If this was the case then this could have implications for what is considered
to be withdrawal. This could imply, for example, that smokers may be abnormally
anxious whilst smoking, hence negative mood may never truly return to ‘normal’
levels after cessation anyway. This would make comparison of mood during
withdrawal to smoking level meaningless.

The smoking withdrawal syndrome appears to vary greatly from smoker to smoker,
with abstinent smokers themselves reporting that withdrawal symptoms differ across
abstinence periods (Hughes et al, 1984). Signs and symptoms of withdrawal appear
to show variability between smokers, although within smokers across time symptoms
appear more consistent. Variables such as setting, expectancy of withdrawal
symptoms and method of cessation may well influence what symptoms smokers
experience and when they experience them. The possibility that these numerous
factors influence withdrawal make the prospect of investigating it difficult, especially
if research is to be reliable and valid.

1.3.3 Time-course of withdrawal

An issue of crucial importance is exactly how long the various repeatedly reported
smoking withdrawal symptoms last, and when they are at there most severe. Gross
and Stizer (1989), testing the effects of nicotine gum on withdrawal, reported that
common withdrawal and desire to smoke generally occur within the first week of
cessation. The withdrawal symptoms commonly reported were depression, anxiety,
irritability, impatience and restlessness. These symptoms were found to peak within
the first week of abstinence and continued to be significantly different from baseline
at five weeks. After this they were reported to return to baseline levels. This research
suggests a potential 6 week time frame for the withdrawal syndrome. Gritz, Carr and
Marcus (1991) investigated withdrawal in unaided quitters and found a similar
pattern of withdrawal symptoms to those reported above. Like Gross and Stizer's study, Gritz et al were looking specifically at the time course of withdrawal. They reported that cravings to smoke and mood symptoms were strongest between 2 days and 2 weeks of cessation, however not all participants reported all withdrawal symptoms and some were reported to re-occur up to 6 and 12 months after cessation. Over 24 hours Parrott, Garnham and Pincock (1996) examined the time course of nicotine withdrawal. They assessed performance on cognitive tasks at 2, 6 and 24 hours into abstinence and subjective feeling states every two hours. These researchers found that compared to continued smoking, abstinence led to feelings of depression, stress, irritability, reduced heart rate, detriments in task performance, poor concentration and urges to smoke. They found that subjective feelings were significantly worse after four hours of abstinence and they reduced in severity over the following 24 hour period. However the first rating on the following day showed that ratings were worse again, perhaps suggesting that symptoms are renewed, or build up, each day. These results do support previous research in terms of decrements in subjective mood, heart rate and performance found during cessation and also potentially point to diurnal variation in symptoms.

Gilbert, McClernon, Rabinovich, Plath, Jensen et al (1997) in researching the time-course of withdrawal highlighted some interesting issues that may prove to be pertinent to this research. Gilbert et al (1997), like others before them, concluded that time course and nature of abstinence responses varied from person to person, as a function of the importance of pharmacological and personality factors. Gilbert et al (1997) conceptualise the withdrawal syndrome as chronic nicotine use leading to biological adaptation to nicotine, which in turn produces tolerance, which in turn produces abstinence effects. During the first week of abstinence progressive re-adaptation to nicotine occurs, which results in the decreases in abstinence effects. Again, as has been found elsewhere, the peak of withdrawal is during the first and second days after cessation. This period of abstinence however is not totally clear, as other researchers have suggested a slightly different time course of withdrawal. For example Hughes, Gust, Skoog, Keenan, & Fenwick (1991) found that directly after cessation, symptoms showed a sharp increase that then subsequently decreased over the preceding 6 months. A significantly longer period than other researchers have
reported (Gross and Stizer reported symptoms significantly declined by 6 weeks). This however may reflect a difference in study methodology rather than difference in time course of symptoms. Hughes et al. (1984) also reported that those with more severe symptoms, those that exhibited more of the common mood effects and who rated said symptoms highly, were generally more likely to fail in their cessation attempt compared to those that had less severe symptoms. Other research has also suggested that the severity of withdrawal symptoms are associated with relapse (Al'Absi, Hatsukami, Davis & Wittmers, 2004), although again this relationship is not completely accepted amongst researchers.

1.3.4 Withdrawal and addiction: Conclusions

From the above research it is clear that although there appear to be some common withdrawal symptoms these are not uniform amongst quitters, and that there is variation in terms of the time scale of which these symptoms are exhibited. There is also a degree of ambiguity within the literature as to how related withdrawal symptoms are to relapse. For example Shiffman (1992) notes that most relapse episodes are associated with negative affect, particularly anxiety, anger and depression. Although Shiffman goes on to state that these symptoms may not be as crucial to relapse as expected, over a half of relapse episodes occurring without symptoms. It seems that withdrawal is certainly strongest in the very early stages of cessation and as such when attempting to measure withdrawal change this period should be considered crucial. There is also the possibility that other factors may well be involved in the withdrawal syndrome, for example personality factors and motivation (Russell, Peto & Patel, 1974). The fact psychological withdrawal dynamics appear complex and varied makes the possibility of a unifying cessation aid seem unlikely. This is not to say however that new cessation methods cannot potentially improve current cessation success rates. From the profile of smoking withdrawal that has been researched so far, it may well be the case that individual smokers will benefit more from certain cessation procedures rather than others.

In conclusion, withdrawal is a crucial factor in smoking cessation, it is experienced by the vast majority of smokers quitting and as such is the main target for the
majority of cessation aids that are currently available. Withdrawal has been shown to predict cessation relapse although some research has not found this to be the case. Hughes et al (1994) concluded, along with many other researchers in this area that withdrawal symptoms occur from 6-12 hours after cessation and that symptoms peak around 2-3 days, which is then followed by a slow decrease in symptoms over the next 6 to 12 months. Individual differences in terms of what symptoms are experienced are often varied and as such variation in withdrawal symptoms will almost always occur.

1.4 CURRENT CESSATION METHODS

There are a number of cessation aids currently available to smokers, all of which are successful to some extent at increasing cessation success. However it seems likely that most attempts to cease smoking are made with will power alone (West, McEwan & Bates, 1999; West, McEwan, Bolling & Owen, 2001) although only 2-4% of these individuals are likely to be abstinent from smoking at 12 months (Hughes et al. 1992). Even with the most effective smoking cessation treatments, combining nicotine replacement therapy (NRT) with behavioural support, abstinence rates are likely to increase by only approximately 15% (Silagy & Haines, 2001). Velicer, Fava, Prochaska, Abrahms, Emmons et al (1995) point out that an intervention such as a smoking cessation clinic might have a 40% cessation rate but might only involve 5% of the smoking population, which results in a total impact of only 2% on overall percentage of people smoking.

Nicotine Replacement Therapy (NRT) is the most common pharmacological cessation aid. NRT comes in various forms but all methods are based on the same principle, they provide nicotine for the quitter in order to relieve or ‘take the edge off’ desire to smoke and experienced withdrawal symptoms. Foulds (1993, 1996) investigated the effectiveness of multiple methods of nicotine replacement therapy and reported that all methods increase cessation rate when compared to quitting without any type of cessation aid. Silgay, Mant, Fowler and Lodge (1994) conducted a meta-analysis of studies looking at the effectiveness of NRT. The authors found that NRT was effective at reducing withdrawal symptoms compared to matched
controls increasing the odds of quitting significantly. In the studies they reviewed, over 18,000 participants took part and it was found in all cases that NRT was more effective in helping them stop smoking than when NRT was not offered. This applies to all forms of NRT and is independent of differing methodologies of trials included in the review (Silgay et al, 1994).

Investigations into the effectiveness of specific forms of NRT have also been undertaken. Nicotine gum, as its name suggests, is a chewing gum that contains nicotine. Repeated chewing causes this to be realised and is subsequently absorbed by the users via the blood stream, by absorption through the lining of the mouth. One example of research investigating this approach was conducted by Fortman and Killen (1995), who looked at the effectiveness of nicotine gum alongside a behavioural treatment programme for smoking relapse prevention. Fortman and Killen reported that nicotine gum did indeed increase cessation. Other researchers have also reported similar results (Gross & Stizer, 1989).

Another form of NRT works by nicotine entering the body via nicotine trans-dermal patches. These can be of varying strengths and can be worn over differing periods of time. They have been shown to be effective at reducing withdrawal and significantly increasing cessation success after 6 weeks when compared to placebo (Glover & Glover, 1994; Jorenby, Leischow & Nides, 1999). Other methods of nicotine delivery are also available including nasal spray, inhalation by mock cigarette as well as nicotine in tablet form, lozenges and microtab (minute nicotine release tablets). All these various methods have similar success rates in terms of improving cessation success (Shiffman, Dresler, Hajek, Gilburt, Targett et al, 2002). However, they do not appear to be the panacea of smoking cessation that they were once thought to be, as many of these approaches have various side effects that may reduce their effectiveness. For example patches can cause adverse skin irritation and nasal spray has been found to cause excessive sneezing and nose bleeds. Actual increases in cessation whilst using these products do not always amount to a large increase in overall cessation success, 9.35% compared to 5% for placebo has been reported (West, 1993). Even with the use of these cessation aids relapse remains high (Stapelton, 1998). There is also the issue of cost as many of these methods are
expensive, although they are available on prescription this in itself could present a
barrier for smokers who are reluctant to see their GP or local nurse. Also some
methods can cause long term dependence themselves, for example 6% of nicotine
gum users have been reported to still be using it up to a year after they first started to
use it (Hajek, Jackson & Belcher, 1988) although this is arguably better than being
addicted to cigarettes.

A relatively new approach to cessation is the use of psychoactive substances, like
Bupropion (Zyban®), to aid cessation. Although originally designed as an anti-
depressant it was found that depressed patients on this medication lost their desire to
smoke. Bupropion has subsequently become relatively widely used. Roth and
Westman (2001) found that Bupropion could be effective at reducing withdrawal
symptoms and increasing cessation success although some side effects were reported
(some of which were severe enough to cause serious concern in participants). These
results have been replicated elsewhere, with a sustained-release form of Bupropion
being found to be effective at increasing smoking cessation, and was also
accompanied by reduced weight gain and side effects (Hurt, Sachs, Glover et al,
1997; Tonstad & Johnston, 2004). Bupropion is not the only psychiatric drug that
has been found to be effective at aiding cessation attempts. West, Hajek and McNeill
(1991) for example provided preliminary evidence that found that buspirone was
effective as a short-term aid to smoking cessation. Hughes, Stead and Lancaster
(2001) looked at various anxiolytics for use as cessation aids and concluded that
evidence was not conclusive, specifically the mechanisms that may be involved in
the effect. However, the authors concluded there was enough evidence to support the
notion that these pharmacological agents may be effective in terms of reductions in
symptoms of withdrawal and in improving overall smoking cessation success.

There has also been research into other methods that may prove useful in reducing
the withdrawal syndrome. For example, West (2001) investigated the possible
efficacy of using glucose as a cessation aid. Results suggested that glucose may
reduce withdrawal and subsequently increase chances of quitting successfully. Hajek
and Stead (2000) reviewed research investigating the possible use of aversion
therapy for smoking cessation, that is pairing an unpleasant stimulus with smoking in
order to reduce and eliminate desire to smoke. The authors suggest that rapid smoking may be a useful aid to cessation although a lack of methodologically rigorous research limits its use.

Overall researchers generally advocate the use of NRT with accompanying behavioural support as the best approach to smoking cessation. Focusing on treatment rather than motivating people to stop appears to be the current aim of cessation, as saturation of motivational interventions, in the form of media campaigns and the like makes such approaches less useful than actually focusing on helping those smokers who wish to stop smoking (Foulds, 1996). However amongst some smokers the use of NRT is often avoided, in smokers with cardiovascular disease for example, despite the fact advice suggests with the correct delivery the use of NRT in this group is acceptable (McRobbie & Hajek, 2001). There are also potential problems of dependence related to NRT. Some research has suggested that NRT can lead to dependence, although the risk of this may not be particularly high (West, Hajek, Foulds, Nilsson, May et al 2000).

1.4.1 Social approaches to smoking cessation

Smoking counselling and cessation groups also provide a valuable tool to aid cessation. They have been found to be effective in helping smokers to begin cessation and to remain abstinent, compared to intensive individual counselling (Stead & Lancaster, 2002). A particular approach used within the UK has been withdrawal-orientated therapy for smokers (Hajek, 1989). This involves focusing on helping smokers to overcome the initial physical withdrawal of smoking abstinence by assisting smokers through behavioural support, social support and use of NRT. The approach lasts 7 weeks and has been found to be effective at helping smokers stop (Sanchez, 2003). Factors such as age, the individuals’ belief in their ability to stop smoking and smoking related to stress have been found to affect how successful such a behavioural approach to cessation is (Chryssanthopoulou & Sharmon, 2003). Analysis has shown that those who are contemplating quitting are five times more likely to go to a cessation clinic compared to those in the pre-contemplation stage of smoking cessation, according to the transtheoretical model of behaviour change.
(Prochaska, DiClemente, & Norcross, 1992). It has also been found that heavier smokers and older smokers are more likely to attend smoking cessation groups. New forms of communication have provided internet-facilitated smoking cessation services, some of which provide tailored smoking cessation advice, however the quality and effectiveness of such new techniques of support have been found to be inconsistent (Hobbis, Mason & Sutton, 2003).

1.5 MEASURING WITHDRAWAL

By having objective measures of withdrawal it becomes possible to measure differences that may be produced via a particular intervention. Evidence presented thus far illustrates, despite variation in withdrawal between smokers, that the collection of symptoms and urges associated with smoking cessation may also be closely related to cessation success. The issues that present themselves here are how best to measure this collection of symptoms and are they consistent enough in order to measure and record changes in them? Direct examination of human drug self-administration is almost always impossible as there are ethical and economic restrictions in attempting to do so. In this research and most other research in the area of smoking, the use of self-report measures of withdrawal symptoms and desire to smoke are necessary. The question thus arises; are these valid and reliable enough measures to be objectively useful?

A number of self-report measures of withdrawal measurement have been extensively used within withdrawal assessment research, and they invariably have consisted of similar items. For example Welsch, Smith, Wetter, Jorenby, Fiore et al (1999) developed a 28-item scale, the Wisconsin Smoking Withdrawal Scale (WSWS), that proposed to measure 7 subscales tapping the major system elements of the nicotine withdrawal syndrome. These consisted of anger, anxiety, concentration, craving, hunger, sadness and sleep. These are constructs that have been commonly associated with acute and chronic nicotine withdrawal within the research literature. This is a typical example of the kind of measure that is used to measure withdrawal and it has a number of problems that are commonly associated with such a self-report measure.
Despite the methodological shortfalls of this approach to measuring withdrawal, research has suggested that these self-report measures can be reliable and valid. Willner et al (1994) conducted a study evaluating the Questionnaire on Smoking Urges (QSU; Tiffany and Drobes, 1991) and found that there was a significant relationship between scores on the QSU and smoking behaviour in the lab. This questionnaire consisted of 32 items that were designed to measure urge to smoke and withdrawal. Factor analysis revealed a two-factor structure that revealed primary intention and desire to smoke and anticipation of pleasure from smoking. These factors do not seem to fit with the previous measure described (WSWS) and this itself illustrates a difficulty with these type of measures, a lack of general consensus about what are the crucial withdrawal symptoms (Shiffman, West & Gilbert, 2004).

Patten and Martin (1996) in a review of self-report measures of tobacco withdrawal, concluded that in the majority of research investigating tobacco withdrawal self-report measures are used as the primary means for assessment. Patten and Martin believe that in the majority of cases these measures have insufficient reliability and validity. They suggest a number of recommendations for the use of these measures in future research, for example, obtaining baseline measures of tobacco withdrawal prior to smoking cessation in order to detect cycles, trends and other fluctuations within smoking abstinence. However, if the aim of research is to investigate acute withdrawal this may have a bearing on whether these recommendations are applicable. They also suggest that several withdrawal ratings should be taken during abstinence rather than just one, thus enabling comprehensive information on the time-course and duration of withdrawal to be gathered. Again whether this is possible will often depend on the methodological nature and particular aims of research.

These recommendations are an attempt to construct a standardised procedure for withdrawal measurement, which in turn illustrates some of the methodological problems associated with measuring withdrawal. Although the considerations presented by Patten and Martin present a potential way to increase reliability and validity of self-report measures some of these methods may not be appropriate in certain research settings (for example the use of behavioural or physiological
measures may not be practicable due to time and resource). However, Patten and Martin fail to acknowledge that specific measures will have their own associated problems and methodological limitations.

Shiffman, West and Gilbert (2004) also addressed a number of methodological issues with the assessment of nicotine withdrawal in trials of smoking cessation. The authors point out that there are a number of standardized measures in widespread use, some of which have been specifically designed to assess withdrawal whilst others are more general mood scales. It is also emphasised that in a large amount of research various rating methods are used ranging from visual analogue scales, fixed point rating scales and check boxes. One potential reason for the variability in measures used may be that it is not possible to assess the true validity of such self-report measures. The authors go on to conclude that none of the existing scales has yet demonstrated sufficient reliability and validity for them to be adopted as universal measures of withdrawal. As such the use of one standardized measure is not required, although it is recommended that researchers should use, wherever possible, validated and published measures that have already been used in similar methodological settings.

Another issue related to the above is how many items these measures should consist of? For example, is one item per symptom enough? As when measuring individual symptoms it would be convenient to use just one item per symptoms. This approach has been embodied in at least one widely used withdrawal scale (see West & Russell, 1985). When single items and multiple item measures have been compared no evidence of a significant difference in reported symptoms have been found (West & Hajek, 1997). Also the practical costs and lack of direct evidence that suggests multiple item measures perform better than single item measures suggests that the use of multiple items should not be taken as necessary in withdrawal related research. Hence with sufficient methodological rigour single item measures are sufficient to measure withdrawal and withdrawal change.

In terms of the symptoms and constructs these measures should incorporate Shiffman et al (2004) recommends the use of items measuring desire to smoke, irritability, depression, restlessness, sleep disturbance, difficulty concentrating, increased
appetite and weight gain. These symptoms have been reported widely in the literature and as such these conclusions seem valid. Although it is important to note that some of these suggestions, weight gain and sleep disturbance, may not be appropriate symptoms to measures in investigations that only measure withdrawal acutely. It is also clear from the wealth of research in this area that using self-report measures can produce valuable information about smoking and should continue to play a major role in the measurement of craving (Tiffany, Carter and Singleton, 2000). Sayette, Shiffman, Tiffany, Niaura, Martin et al (2000) conclude that none of the self-report measures used within the smoking literature are appropriate across all settings and thus issues to do with the specific research environment must lead the decision as to what measure to use. Relevant issues might include the anticipated level of abstinence effect, any time constraints when administering tests and previous research using the same measures. By taking into account these factors it should be possible to use the most suitable measure of withdrawal and in doing so measure withdrawal and desire to smoke in the most reliable and valid way possible.

1.6 CONCLUSIONS

Extensive evidence has been presented that has demonstrated the negative physiological consequences of smoking to health and the mechanisms and anatomical structures involved in this process. Smokers have increased risk of mortality from numerous chronic and acute conditions, including lung cancer, CHD and respiratory illness. As a national phenomenon, a large proportion of the population still smokes, approximately 25%, and of this group around 70% state they wish to stop smoking. Smoking related illness remains a huge economic burden on the NHS, and as such is a major area of interest at government level. Current cessation methods, although effective when used, tend to only increase levels of cessation to around 15%. Clearly new and innovative methods of cessation are required. Research has demonstrated a number of psychological implications for smoking cessation. This has provided a wealth of empirical findings that suggest smoking cessation is immediately followed by certain withdrawal symptoms (such as stress, anger, anxiety and desire to smoke). Although these symptoms have been reported quite consistently within the literature they generally appear to be of an
atypical nature and time course. Despite the inconsistency of some withdrawal symptoms desire to smoke has been the most persistent symptom reported.

Physical activity has been mooted as a potential new method to achieve cessation, or at least to aid cessation attempts (Ussher et al, 2001) although some have doubted the usefulness of such an approach (Munafo et al, 2003). Research, that will be explored in detail in the proceeding chapter, suggests that physical activity has psychological benefits, specifically alleviation of the mood states that are commonly associated to acute and chronic nicotine withdrawal. The following chapter will outline this research.
CHAPTER TWO

EXERCISE: PHYSIOLOGICAL, PSYCHOLOGICAL AND METHODOLOGICAL ISSUES

2.1 INTRODUCTION

Research investigating exercise and mood will now be reviewed, as issues raised within this area are highly relevant to research investigating the relationship between exercise and smoking. This is a huge area in itself and as such merits comprehensive investigation and research in its own right, more than there is sufficient space, or time, for here. However, a detailed analysis and review of the most important and relevant aspects of this research area will be undertaken, highlighting the crucial issues. Firstly, the physiological consequences of exercise, both of an acute and chronic nature, will be discussed. The issue of how the exerciser reacts psychologically to exercise will then be outlined, providing an account of what is known about this relationship and what may be lacking in this research area. An understanding of how exercise and psychological state interact is essential if research is to attempt to explain how the positive psychological effects of exercise on smoking cessation might occur. There are also specific methodological considerations to take into account when examining exercise related research, these will also be discussed. Exercise here means structured as well as unstructured, life-style physical activity such as house work and walking.

2.2 PHYSIOLOGICAL CONSEQUENCES OF EXERCISE

Some of the physiological effects of exercise are relatively well known and have been researched extensively, in particular the acute and chronic effects of exercise on physical health. For example Blair, Kohl, Paffenberger, Clark, Cooper et al (1989) found, in a large longitudinal survey (n = 13,344) that exercise was negatively related to all causes of mortality, including cardiovascular heart disease (CHD) and cancer. Higher rates of physical fitness appeared to delay all cause of mortality, primarily
due to decreased rates of these chronic illnesses. Research has also found the reverse of this relationship, namely that lower incidences of CHD are found in fit, active individuals (Williams, 2001). Morris, Everett, Pollard and Edwards (1980) also found an inverse relationship between vigorous exercise and coronary heart disease. Morris et al found that vigorous exercise performed in leisure time (this included sports participation and exercising to keep fit) had a positive effect on health. Specifically the authors found that rates of CHD in men who engaged in this type of activity were lower in both fatal and non-fatal manifestations of CHD. Morris et al concluded that vigorous exercise is a natural defence, which produces protective effects on the heart against disease and its consequences. In fact attributable risk estimates of all-cause mortality indicated that lack of physical fitness was an important risk factor in both men and women. Stromme and Ingjer (1982) reviewed evidence for the effects of physical activity on cardiovascular systems and concluded that regular exercise leads to adaptational changes to the size of the heart, its' function and its' pump capacity. They assert that these changes in turn have a beneficial effect on health, in particular lessening CHD risk. Similar findings have been reported in numerous other studies (Bhargava, 2003; Fang, Wylie-Rossett, Cohen, Kaplan & Alderman, 2003; Hickey, Mulcahy, Bourke, Graham & Wilson-Davis 1975; Rastogi, Vaz, Spiegelman, et al, 2004; Savage, Brochu, Poehlman & Ades, 2003). Although some evidence has suggested too much exercise can be detrimental to health (American College of Sports Medicine, ACSM, 2003).

There are a number of explanations for the positive association between exercise and health. Nelson, Jennings, Esler and Korner (1986) found that long-term physical activity reduced blood pressure and blood flow, factors that point to the potentially beneficial effects of exercise on health due to decreased incidences of hypertension. An interesting feature of the methodology employed in Nelson et al’s study was that three bands of exercise level in participants were investigated, participants who were sedentary (did no physical activity), who did moderate levels of exercise (cycling at 60-70% of HRR three times a week) and more frequent exercisers (as moderate intensity, but 7 days a week). They found that moderate intensity exercise at three times per week was an important non-pharmacological method of reducing levels of hypertension, and was just as effective as more frequent moderate intensity exercise.
at precipitating these positive health benefits. This is in line with current recommendations for physical activity (ACSM, 2003).

Further support for the health benefits of exercise can be found in the literature on cancer. For example cancer has also been shown to be inversely related to exercise (Vena, Graham, Zielenzy, Swanson, Barnes et al, 1985). A large amount of research, most of it from a medical research perspective, has established that exercise is related to reduced mortality due to reduced risk of cancer and to increased longevity in general (Lee et al, 1995; Paffenberger & Hale, 1975; Paffenberger, Wing & Hyde, 1978; Paffenberger, Hyde, Wing & Hsiech, 1986; Paffenberger & Hyde, 1988).

Research has also shown that physical activity is predictive of good health in later years, particularly in terms of number of symptoms reported, e.g. as measured by electrocardiography (ECG) readings and biochemical state (Cheraskin & Ringsdorf, 1971). Participation in regular exercise over an 18 month period has also been found to be associated with weight reduction, increased stamina and better health in general as well as better ability to deal with stress and increased positive self-image (Heinzelmann & Bagley, 1970).

In summary empirical evidence has demonstrated that physical activity, both structured and un-structured, of moderate to vigorous intensity, has a beneficial effect on physiological health. Regular exercise produces increased longevity and reduces the prevalence of many of the major health problems associated with the western world, specifically cancer and CHD. However these are not the only benefits, as research to be presented will demonstrate the psychological implications of taking part in exercise can also be just as positive.

2.3 PSYCHOLOGICAL EFFECTS OF EXERCISE

There has been a large amount of research conducted that suggests that physical activity can have positive psychological as well as physiological effects. One of the first investigations of the potential relationship between exercise and mental health was conducted by Layman (1960). Layman emphasised the principle of mind-body
unity, and that the close relationship between organic health and adequate adjustment implies exercise is beneficial psychologically, as well as physiologically. Many other researchers have reported empirical evidence supporting the link between exercise and improved mood since Layman made this original conclusion. Numerous sources have concluded that exercise has benefits on negative mood (these will be described shortly). As discussed in the previous chapter disturbed mood is a key feature of smoking withdrawal and as will become clear much evidence suggests that exercise effects these same mood constructs. For the sake of parsimony the research findings will be reported by the specific mood and emotion states they investigate, i.e. anxiety and depression separately, and then to conclude with research that examines multiple mood states and emotions.

2.3.1 Anti-depressant effects of physical activity

Research into the effects of exercise on depression has been conducted both in depressed populations as well as in mildly depressed and ‘normal’ populations. The sample of participants used, be they a clinical or non-clinical population, is relevant as methodologies employed to investigate these separate populations differ. Population studies have found significant relationships between physical activity level and depression in the general population (Stephens, 1988). Within populations, those involved in most physical activity have been found to have smaller incidences of depression disorders. It has also been found that depressed patients are characterised by reduced physical work capacity when compared to the general population (Martinsen, Strand, Paulsson & Kaggestad, 1989; Morgan, 1969). This research, predominantly based on correlational analysis, points to a significant inverse relationship between depression and physical activity.

Cross-sectional and longitudinal studies have consistently reported high levels of physical activity alongside better mental health, including decreased levels of depression (Salmon, 2001). Steptoe and Butler showed in a large cohort sample of adults (n = 5,061) that participation in vigorous exercise was related to lower emotional distress. Similarly Steptoe, Wardle, Fuller Holte, Justo et al (1997) reported exercise being significantly correlated with lower depression in a sample of
16,483 university students. Longitudinal research has also supported this research. For example Paffenberger, Lee and Leung (1994) found that depression and physical activity were negatively associated approximately 25 years later in a sample of 10,201 men. Other longitudinal research has reported similar results (Camacho, Roberts, Lazarus, Kaplan & Cohen, 1991).

Acute research studies have also been conducted investigating the efficacy of various types, durations and intensities of physical activity as a potential therapeutic treatment for depression. Mather, Roidriguez, Guthrie, McHartg, Reid et al (2002) aimed to determine if exercise was effective, as an adjutant to antidepressant therapy, in reducing depressive symptoms in older adults. Participants were randomized to exercise classes or health education talks for a period of 10 weeks. It was found that at 10 weeks a significantly higher proportion of the exercise group experienced a greater decline in depressive symptoms compared to controls. In fact a 30 % average decrease in symptoms was reported in the exercise group. Other researchers report similar findings, for example Greist, Klein, Eischens, Faris, Gurman et al (1979) compared running therapy with two traditional forms of individual psychotherapy. Greist et al reported that significant reductions in depression were found in all groups. No differences were reported in this reduction across the conditions perhaps indicating the exercise therapy was just as effective as psychotherapy at reducing depressive symptoms.

Other researchers have also reported significant reductions in depression following exercise for a similar 10 week exercise programme, for example (Sime, 1987), and in shorter periods, 6 weeks of exercise treatment for example (Doyne, Chambless & Beutler, 1983). Blue (1979) reported that depressed patients, after taking part in an exercise programme, experienced reductions in levels of depression. Many other studies have reported the potential beneficial effects of exercise on depression, compared to other forms of more conventional therapy, for example supervised running verses counselling (Reuter, Mutrie & Harris, 1982) and aerobic exercise with cognitive therapy over 10 weeks compared to cognitive therapy alone (Freemont & Craighead, 1987). Some research has suggested that acute, light intensity exercise, is
also effective at reducing depression in clinically depressed participants (Brown, Goldstein-Shirley, Robinson & Casey, 2001).

Research has also implied that physical activity can prevent or pre-empt the onset of depression and depressive symptoms. For example Gotestam and Stiles (1990) studied stress and physical activity in a group of soldiers exposed to stress. They reported that those soldiers who were actively involved in physical activity were significantly less depressed 12 weeks after exposure to stressful life situations. Martinsen, Sandvik and Kolbjomsrud (1989) found similar results in an adult sample, where exercise and sport predicted lower depressive symptom scores. It has also been found that at 1 year follow up, patients report physical activity to help them the most therapeutically when compared to psychotherapy (Martinsen & Medhus, 1989). This findings has been further supported by other research (Sexton, Maere & Dahl, 1989). This research points to the potential protective effect physical activity may have for depressive disorders. Recent evidence suggests that this is the case although factors such as age, as well as individual differences, seem to be associated with this protective effect (Fukukawa, Nakashima, Tsuboi, Kozakai, Doyo et al 2004; Motl, Birnbaum, Kubick & Dishman, 2004; Wang & Brown, 2004).

Research has attempted to explain how exactly exercise reduces depression. Martinsen, Medhus and Sandvik (1985) randomly assigned depressed patients to either aerobic exercise or a control condition. Exercise consisted of jogging and brisk walking for 1 hour, three times per week for 6 to 9 weeks. It was found that patients suffering from depression showed significantly greater decreases in symptoms compared to controls. Further analysis revealed that this effect was at least to some extent dependent on degree of improvement in aerobic fitness, hence improvement in actual fitness was suggested as a mechanism by which this effect occurs. This has not been widely supported by other research though (Doyne, Ossip-Klein, Bowman, Osborn, McDougall-Wilson et al, 1987; Martinsen, Hoffart & Solberg, 1989). Despite this lack of collaborative evidence it remains a possibility that a training threshold may exist in order to ensure exercise reduces depressive symptomology.
The experimental evidence outlined above predominantly deals with how exercise might be used as a therapeutic tool for patients with depression. Research has also been conducted within populations without depressive disorders and participants with mild or borderline, or non-clinical depression. Morgan (1970) for example looked at 8 exercise programmes compared with equal contact controls in a sample of 140 participants. Exercise included running, circuit training, swimming and cycling. This physical activity was completed at 85% of participant’s maximal heart rate, two to three days per week (this equates to vigorous physical activity, ACSM). Morgan et al reported no significant differences in self-reported measures of depression after any of the types of exercise, however those participants that did initially score highly on the self rated depression scale (SDS; Zung, 1965), particularly those reaching levels of clinical significance, did report a significantly decreased level of depression. This has been found elsewhere also (Lane & Lovejoy, 2001). Other research has also reported no significant decreases in depression post-exercise, despite increases in fitness and power in non-clinically depressed populations (Morgan & Pollak, 1978; Stern & Cleary, 1982). This finding is perhaps not so surprising as depression can only be seen to be reduced if depression is present within the participant to start with. This is not to conclude that exercise cannot reduce depression in these groups though, rather that reductions may not be large, McDonald and Hodgdon (1991) reported that the anti-depressant effects of exercise were approximately 40% greater in depressed groups compared to non-depressed groups.

Other evidence does suggest that exercise can reduce depression in non-clinical populations. Farmer, Locke, Moscicki, Dannenberg, Larson et al (1988) conducted a epidemiological study that assessed past and current depression, alongside current level of physical activity in healthy participants. Farmer et al reported that those who took part in little or no physical activity were cross-sectionally associated with depressive symptoms. Recreational physical activity was found to be an independent predictor of depressive symptoms on average eight years later, although this was only found in white female participants (it was unclear why this was the case).
In summary research investigating the anti-depressant effects of exercise in depressed populations has found that physical activity can be efficacious in reducing symptoms. This has been found in a large number of empirical investigations and over a variety of intensities and durations of physical activity. Also in non-depressed participants the effect has been seen to occur, although this may be more transitory in nature compared to reductions of depression in clinical populations. Overall the research with this population is less conclusive (Martinsen & Morgan, 1997). This effect has been demonstrated across a variety of research methodologies, using different types of exercise interventions, from home-based exercise to supervised exercise in outpatient and inpatient settings (Salmon, 2001). There is however a lack of evidence reporting the intensity of exercise required to exhibit these effects. Some research has suggested that running and walking are just as effective in reducing symptoms (Sexton et al, 1989) although lack of control conditions make interpretation of this particular research problematic. A clear understanding of the intensity and durational limitations of this effect are at present lacking.

2.3.2 Anxiolytic effects of physical activity

Research has been conducted investigating the specific effects and potential benefits physical activity may have on anxiety, both in clinical and non-clinical populations. Steptoe, Edwards, Moses and Mathews (1989) for example examined the effects of moderate aerobic exercise training on mood and perceived coping ability, amongst anxious adults. Training consisted of one supervised and three unsupervised exercise sessions of moderate intensity exercise per week, for a period of ten weeks compared to an attention control group and an alternative exercise group (flexibility and strength training). It was found that after the moderate exercise programme there were significant reductions in tension and anxiety and these changes lasted up to three months after the study was completed. No changes were observed within the other two conditions. This evidence suggests exercise may reduce anxiety in a clinical population.

Reviews of the physical activity and anxiety literature have reported beneficial effects of acute and chronic exercise on anxiety. State anxiety has been found to be
reduced, directly, and up to 7 hours after, short bouts of vigorous intensity exercise (Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991). However, whether these benefits are applicable to both patient and non-patient populations has become a contentious issue. Meta-analytic reviews provide conflicting results on this issue, McDonald and Hodgdon (1991) support the use of exercise in both populations, whereas others believe that the anxiolytic effects of exercise may be limited to certain groups (Schlicht, 1994). Although there are discrepancies in the literature, it has been suggested that the differences presented in these cases may be due to differences in meta-analytic techniques, rather than an actual difference in the data.

From a review of this research area Petruzzello et al (1991) found that exercise resulted in state and trait reductions in anxiety, as has also been found to be the case in other reviews of this area (McDonald & Hodgdon, 1991). Investigators have found acute anxiety improvements associated with acute physical activity compared to control and resting conditions (Crocker & Grozelle, 1991; Eide, 1982; Raglin & Morgan, 1987; Roth, 1989) as well as being as effective as relaxation at reducing anxiety (Bahrke & Morgan, 1978). Morgan (1997) points out that these studies, although pointing to the anxiety reducing features of exercise, do not provide a consistent picture of the relationship. In particular in terms of the intensity of exercise required to elicit these effects. Although early work suggested that intensities of moderate exercise or above were enough to exhibit these effects other research has been less clear (Farell, Gustafson, Morgan & Pert, 1987). It is only relatively recently that inconsistencies within this research have been acknowledged in the literature, and have begun to be addressed.

Other researchers have suggested that high intensity physical activity delays the anxiety reducing effects of exercise. For example Raglin and Wilson (1996) found that state anxiety significantly increased directly after 20 minutes of exercise at 70% of VO\textsubscript{2max}, although increases appeared to be transient. At 60 minutes after this intensity of exercise anxiety reductions were observed. It may be the case that high intensity exercise delays reductions in anxiety rather than eliminates them altogether. McAuley, Mihalko and Bane (1996) examined whether exercise, performed at participants perceived exertion rate of hard intensity reduced anxiety and whether
setting of the exercise (in a lab or outside) affected anxiety reductions. Results indicated that exercising at a perceived ‘hard’ intensity in both laboratory and natural environments had a significant impact on anxiety when compared to resting control conditions. Anxiety reductions were observed regardless of setting.

Methodological issues pose questions about the validity and reliability of results and conclusions in this research area. For example, Rejeski, Hardy and Shaw (1991) found reductions in anxiety after 15 minutes of moderate to vigorous intensity exercise, although the reliability of the anxiety measured they used has been questioned (the Spielberger State Anxiety Inventory, SAI; Spileberger, 1983). The authors themselves noted that changes in SAI scores were strongly associated with energetic arousal and other variables, which might suggest that anxiety is not really reduced due to exercise rather it these changes in other variables that effect anxiety ratings. Other authors have also questioned the use of the SAI (Ekkekakis, Hall & Petruzzello, 1999). As many studies examining anxiety in the context of physical activity have used the SAI this may question the validity of the findings of numerous studies. Another problem is that many studies have used questionable control groups, and lack the use of validated measures. These are but a few of the problems that appear to plague this research area.

Overall the majority of research in the area of anxiety reduction has been conducted using aerobic exercise, like running and cycling. The research described so far has predominantly used a ‘normal mood’ population, although there has been some research looking into the effects of exercise in persons with diagnosed anxiety disorders. The research in this area is limited, possibly due to the findings of early research that suggested that vigorous exercise in anxiety disorder patients could result in an increase in the chances of experiencing panic attacks (McDonald & Hodgdon, 1991: Pitts & McClure, 1967). Methodological concerns with these research findings resulted in investigations that suggest exercise might be a useful therapeutic tool for this population. Taylor, King, Ehlers, Margraf, Clark et al (1987) compared treadmill exercise in 40 patients with anxiety disorder and 40 age matched control participants. Taylor et al found that anxiety disorder patients were significantly less fit, but there was no evidence that they were exercise intolerant or
would be negatively affected by exercise. Other investigators have also reported
similar findings (Gaffney, Fenton, Lane & Lake, 1988). Stein, Papp, Klein, Cohen,
Simon et al. (1992) concludes that moderate intensity exercise is safe and not
contraindicated in anxiety disorder patients and as such exercise should be
encouraged in this population. Research has suggested that training programs can
result in significant reductions in trait anxiety in these clinical patients (Petruzzello,
Landers, Hatsfield, Kubitz, & Salazar, 1991) although benefits may be most
pronounced in those with the largest elevations in levels of anxiety.

Other researchers however have suggested the opposite i.e. that anxiety may actually
increase during exercise itself rather then be reduced. Morgan and Horstman (1976)
offered a summary from a review of seven consecutive studies investigating state
anxiety reduction due to moderate and vigorous intensities of exercise. The authors
found that anxiety seemed to increase during the first half of exercise sessions, where
it then reached a plateau. These anxiety levels remained elevated during exercise and
then decreased immediately after exercise. By 10 minutes after exercise decrements
in anxiety below baseline were observed. Rejeski et al concluded that the reason for
this pattern may be that cognitive changes in anxiety occur during exercise, and the
behavioural changes in anxiety occur after it. This remains a plausible explanation
for the effects of exercise on anxiety, although there is little other evidence for this
theory. It is also a possibility that anxiety could be increased due to taking part in the
experiment itself, a fact that is often overlooked in this research area.

The effects of exercise upon anxiety is a relationship very similar to that observed in
depression research. Evidence is mixed regarding issues such as what durations and
intensities are required to exhibit positive effects on anxiety, however the majority of
the experimental evidence suggests that there are reductions in anxiety following
exercise (Steptoe, 1992, 1994). This appears to particularly be the case with acute
exercise, intensity between 50% and 80% of HRR (this is moderate intensity
exercise). Evidence specifically looking at possible physiological mechanisms
responsible for exercises effect upon mood has found that reductions in anxiety
following exercise may be due to changes in brain activation (Petruzzello & Landers,
1994), this however is only a tentative suggestion at present. Steptoe concluded that
methodological limitations and differences make this large body of work far from conclusive. Problems such as non-standardized measures and reliance on subjective recall are seen throughout this research area. There is often a lack of adequate quantification of fitness of participants and exercise intensity, and use of indirect methods to measure these variables also creates reliability and validity problems. Despite these issues there is sufficient evidence to suggest that moderate intensity exercise is able to produce significant reductions in both state and trait anxiety, and as such exercise may prove a useful tool in reducing anxiety in a variety of different populations.

2.3.3 General mood effects

Many investigations of the effects of exercise on mood have looked at multiple facets of mood and emotion rather than just specific mood constructs. Many researchers in the exercise and mood area have implemented general mood measures within research in an attempt to determine changes in a wide variety of mood constructs. The Profile Of Mood States (POMS); McNair, Lorr and Droppleman, 1981) for example has been widely used in the exercise field. The POMS requires participants to rate on Likart scales a number of questions that are combined to form six separate sub-scales; tension-anxiety, depression-dejection, vigour-activity, fatigue-inertia, and confusion-bewilderment. Maroulakis and Zervas (1993) used the POMS (as well as other mood measures) to record multiple aspects of mood directly after an exercise session and then a further 24 hours after exercise. Results indicated that general mood was significantly different after the exercise session in both periods, with decreases in negative mood and increases in positive mood. Other researchers have also reported similar findings (Keer & Kuk, 2001)

With regard to the use of the POMS as a general measure of mood, Berger and Motl (2000) produced a review of a number of studies that have used the POMS in physical activity research, investigating mood and exercise. The results of many studies using the POMS were found to have supported the relationship between exercise and acute changes in mood in normal populations and more chronic mood changes in clinical populations. Berger and Motl therefore concluded that the POMS
was a sensitive measure of the effects of experimental manipulations and is thus useful in exercise research, however they point out that the POMS was initially designed for use with clinical populations. This may make comparisons with normal populations somewhat problematic. Exercise specific measures of mood have been developed, (for example the Subjective Exercise Experience Scale; McAuley & Courneya, 1994) and this type of measure may be more appropriate for use in exercise studies.

Large scale studies looking at overall psychological effects of exercise have also been conducted. Moses, Steptoe, Mathews and Edwards (1989) conducted a study aiming to compare the effects of two aerobic training programmes, of different intensities, on mood and mental well-being, compared with an attention controlled placebo condition. Over one hundred participants either took part in a 10 week training programme, completing either high intensity aerobic exercise or moderate intensity aerobic exercise. Psychological benefits were seen in the moderate, but not the vigorous, exercise conditions. These were manifest immediately after exercise with significant reductions in anxiety, tension and confusion and at follow up on measures of perceived coping ability. Other authors have reported these said same changes due to exercise as well exercise increasing social benefits, social harmony and social change (Wankel & Berger, 1990).

Scully, Kremer, Meade, Graham and Dudgeon (1998) compiled a critical review of the research investigating physical activity and psychological well-being. The predominant message from this particular review stated that the relationship between psychology and exercise has proved more complicated than the relationship between physiology and exercise. Although Scully and colleagues predominantly support the view that exercise is of psychological benefit, they do add a number a cautionary points. Firstly that research data in this area remains relatively thin. They advocate a need for large scale, multidimensional experimental exercise programmes, with multivariate analysis of covariance in order to fully investigate the complexities of this relationship. They also note that the greatest limitation with this area of research is the lack of evidence to suggest how psychological and physiological processes and mechanisms interact. This is predominantly still lacking from current exercise and
mood research. Despite these methodological limitations, in general the evidence suggests positive general mood improvements after exercise although these may be restricted by a number of factors i.e. individual differences, type, duration and intensity of exercise. The actual intensities required to achieve these psychological improvements has appeared to vary within the literature, although it seems possible that vigorous intensity can have a negative effect on mood. Moderate intensity exercise has predominantly been found to be positively associated with improvements in mood and some evidence suggests that even light intensity, i.e. walking, can have beneficial effects (Ekkekakis, Hall, VanLanduyt & Petruzzello, 2000; Lee, Goldberg, Sallis, Hickman, Castro et al, 2001).

2.3.4 Exercise and Affect

Gauvin and Brawley (1993) believe the investigation of exercise-induced affect is important for two reasons. Firstly, a clear understanding of the relationship between affective changes and exercise would allow mental health and health practitioners to appropriately prescribe exercise for therapeutic and preventative purposes. Secondly, some research has suggested that affect may play a role in adherence to exercise, which is clearly a crucial issue if exercise is to be used in a therapeutic or preventative sense. It may be the case that a separate exploration of mood and how exercise might impact upon it, may be unnecessary. For example, exercise may influence affect in general. A common measure of affect used within exercise research has been the Positive and Negative Affect Schedule (PANAS; Watson, Clark & Tellegen, 1988). This measure uses a two-factor structure conceptualisation of affect. The positive affect (PA) dimension reflects the extent to which a person feels enthusiastic, active and alert. Negative affect (NA) reflects the extent to which a person experiences aversive mood states, such as anger, disgust and fear, low NA indicates calmness and serenity.

Hall, Ekkekakis and Petruzzello (2002) state that due to the lack of a truly unifying theory of the effects of exercise on for example anxiety and depression, a narrow focus on these variables is unlikely to capture the impact of exercise on affect in general. Hall, Ekkekakis and Petruzzello argue that using such measures as the
PANAS in an exercise setting may be appropriate. The authors have proposed that when measuring mood and exercise it may be more appropriate to measure more general domains of mood rather than specific ones. Ekkekakis and Petruzzello (1999) reviewed evidence investigating the dose response relationship between exercise and changes in affect. Affect was found to be significantly influenced by exercise, increases in positive affect and decreases in negative affect were reported, although there were occasions when negative affect increased during vigorous exercise. Contrary to this Petruzzello and Landers (1994) found that increasing durations of exercise caused reductions in negative affect.

Ekkekakis, Hall, VanLanduyt and Petruzzello (2000) note that it is assumed that moderate intensity activities, such as walking, are more enjoyable, or less aversive, to participants than other activities, yet actual studies investigating walking are rare. It has been generally held that moderate intensity was required in order to exhibit positive effects on mood and affect, although the evidence that light intensity exercise was not effective may have been flawed in a number of ways (Sime, 1977). Also recent evidence has suggested that improvements in acute mood occur regardless of differences in intensities or durations of exercise (Petruzello et al, 1991). Steptoe and Bolton (1988), and Steptoe and Cox (1988), have found that low intensity exercise of short durations can improve mood states such as anxiety and depression. Due to these findings and the seeming inability of research to accept that low durations and intensities can be effective Ekkekakis, Hall, VanLanduyt and Petruzzello (2000) conducted four studies to investigate the effects of walking on affect. The first study involved two conditions, a walking condition and a reading control group. Participants in the walking group walked outdoors at a self-selected pace for 10 minutes. Participants completed a battery of measure pre- and post-exercise in order to determine changes in affect. Results indicated that the self-paced, moderate intensity walk was associated with shifts towards higher affective activation and positive affect. One potential problem with these findings however is that as participant were walking outside, it may just be 'pleasantness' of surroundings that are reflected in these changes.
Ekkekakis et al's further studies established that these effects were also seen in the same type and intensity of activity in a lab setting, which might counter the potential bias mentioned above. Affective change appeared to start to revert to baseline levels 10 minutes post-exercise, and these changes were reliable across two separate testing periods within participants. Overall research that has examined the relationship between physical activity and affect has found that exercise increases PA, and has been associated with reductions in NA. These changes may be related to changes reported in other mood states, i.e. anxiety, although this relationship remains unclear. Overall affect appears to be related to acute and chronic exercise in a positive way, again demonstrating the positive psychological benefits associated with exercise. It may therefore be appropriate to measure affect as well as other mood states in exercise interventions in order to determine if indeed this is the case.

2.4 EXERCISE AND MOOD: CONCLUSIONS

A large body of research has found that after moderate to vigorous intensity exercise acute improvements in mood are reported (Lluch Hubert, King & Blundell, 2000), and that both regular, long-term exercise and one-off exercise (Steptoe, 1996) can be effective. There are a number of extensive reviews of the literature corroborating these findings (See Bryne and Bryne, 1993; Yeung, 1996). Undoubtedly exercise accounts for many therapeutic processes including numerous psychological benefits. These include anxiolytic and anti-depressant effects, as well as providing resistance to stress. However some aspects of this relationship are less clear. Salmon (2001) provides a comprehensive review of the evidence on exercise and mood, concluding that the emotional effects of exercise remain confusing; with both positive and negative effects being reported, a fact which undermines much of the research and makes conclusions difficult to substantiate. Salmon and others point out that details, specifically mechanisms responsible for the effects of exercise on mood have not been researched extensively enough, and as such is currently a weakness within this area of research. Despite this, the evidence still overwhelmingly points to exercise improving mood.
When considering the exercise and mood literature it is important that a number of methodological issues specific to this area are acknowledged. Some of these issues in fact go so far as to seriously question the validity and reliability of all work done in this field. Yeung (1996) for example believes that a large number of empirical investigations in this area do not have the methodological rigour to draw valid conclusions regarding the effects of exercise on mood. For example it is important that research is clear about what constitutes acute exercise. Within the body of literature this has ranged from between 15 and 55 minutes, a considerable difference. These methodological inconsistencies make it difficult to amalgamate findings from different pieces of research.

Much of the research in this field is conducted using relatively fit and physically active participants. Less work has been carried out on sedentary samples although what research has been done suggests general mood improvements (Raglin & Wilson, 1996; Steptoe, Kearsley & Walters, 1993). Strenuous exercise in participants who are not habitually used to it have been found to produce negative rather than positive mood effects (Petruzzello, Jones & Tate, 1997; Raglin & Wilson, 1996; Steptoe & Bolton, 1988; Steptoe & Cox, 1998), hence studies that do not control for participants habitual activity level may be missing a vital element of the exercise and mood relationship. There is also a potential issue of selection bias in this type of research. Participants with negative experiences of exercise would be unlikely to volunteer for exercise related studies. This bias makes it difficult to generalise findings and in particular to apply these findings to populations that may be sedentary, and who may find exercise aversive, like smokers for example.

Despite these problems Salmon (2001) concludes that exercise undoubtedly provides many non-specific therapeutic benefits, including anxiolytic and anti-depressant effects as well as potentially providing resistance to physiological and emotional consequences of psychological stressors. This is enough to merit further investigation into the use of exercise as a potential therapeutic tool. Despite the methodological discrepancies within much of the exercise and mood literature the overriding position of most researchers is that exercise, both acute and chronic, has predominantly positive effects on mood and affect and reduces negative moods and emotions.
Although this appears to be a somewhat vague conclusion from such a wealth of research it remains to be the case that the inconsistency in methodologies employed make any other conclusion precarious.

2.5 EXERCISE AND MOOD: MECHANISMS

Now that the beneficial effects of exercise have at least in part been demonstrated the next logical question is to what mechanisms and systems are responsible for these improvements. What research that has been conducted investigating this will be briefly discussed in the preceding sections.

2.5.1 The Serotonin Hypothesis

One potential biochemical explanation for exercise related mood changes is linked to the notion the exercise effects biochemistry in the same way that certain anti-depressant drugs work. Specifically that there is a parallel between the mechanisms underlying the anti-depressant and anxiolytic effects of exercise and those involved in the therapeutic properties of 'classical' antidepressants and anxiolytic drugs (Chaouloff, 1997; Delgado, 2004). These drugs predominantly work on central serotonergic systems and it remains possible that exercise operates along the same lines. Studies using animals investigating physical activity and central serotonergic systems suggest that physical activity does modify these systems (Chaouloff, 1989). It thus may be possible to demonstrate that exercise affects some of these serotonergic systems, and also that the mood elevating effects of exercise can be diminished or prevented by selectively affecting central serotonergic tone.

Hoffman, Elam, Thoren and Hjorth (1994) investigated the effects of vigorous intensity running on cerebral levels of serotonin in rats. Hoffman and colleagues found that changes in central monoaminergic systems are one of the effects of exercise, these being associated with regulation of serotonin production. Dey, Singh and Dey (1992) found that acute exercise significantly increased the synthesis of serotonin. Dey et al further concluded that this is significantly related to the antidepressant features of exercise based on the serotonin deficiency theory of
depression. Although these studies use non-human participants, the research supports the theory of a relationship between exercise and serotonin. Despite this positive evidence Chaouloff (1997) in reviewing the evidence for this hypothesis highlights that most work examines amounts of Tryophan, which is a precursor to serotonin regulation. A number of studies do find that exercise increases Tryophan although findings are difficult to interpret, as there are numerous other factors that are important in the synthesis, and use of, Tryophan.

Another potential problem with the serotonin hypothesis is that not all exercise appears to increase levels of serotonin (McMurray, Hardy, Roberts, Forsythe & Mar, 1989) and yet reports have indicated that exercise of most types increases positive mood. This could indicate that serotonin is not primarily responsible for the positive psychological effects of exercise. Some animal research has suggested that acute exercise and subsequent increases in brain serotonin level do not effect anxiety (Chaouloff, 1994). Other human evidence does not support, or at least casts doubt, on the relationship between exercise and serotonin in humans. Jensen, Møller, Smith and Roesenberg (1995) investigated the effects of human blood platelet serotonin uptake following acute exercise. Jensen et al hypothesised that uptake of serotonin is influenced by size of blood platelets. As exercise tends to increase concentration and mean volume of blood platelets then exercise was hypothesised to influence levels of serotonin in this way. Jensen et al however found that after light physical activity there was no significant effect of exercise on serotonin levels in the blood. This seems to contradict other research findings although these contradictory results could be due to level of intensity of exercise employed in this study. Previous research has looked at exercise of a more vigorous intensity (Jensen, Glud & Arnfield, 1984) and has found increases of up to 75% in serotonin, compared to 15% in Jensen et al’s (1995) study. Similar results have been found in other research (Blomstrand, Hassmen & Newsholme, 1991; Davis, Bailey, Woods, Galiano, Hamilton et al, 1992; Fischer & De Meirleir, 1991). These investigations support the notion that serotonin, following exercise, is highly increased in concentration in the brain. The issue is: are these elevations in serotonin level significantly related to changes in mood? At the moment this question remains unanswered. Work beyond this thesis investigating the mechanisms responsible in the mood and exercise relationship needs to examine the
above possibility in more detail. It is not the purpose of this thesis to do this here, it is however important to note that this remains a tenable mechanism in the mood and exercise relationship.

### 2.6.2 The Endorphin Hypothesis

It has been suggested that the endorphin hypothesis is the theory of exercise and mood that has attracted the most attention (Yeung, 1996), with numerous studies demonstrating that exercise is followed by a subsequent increase in plasma endorphin levels (Carr, Bullen, Skrinar Arnold, Rosenblatt et al, 1981). However, actual correlations between these increases and subjective mood changes have generally failed to be recorded or reported. Research has been conducted into the role of opioids in the exercise and mood relationship, which was promoted by the discovery that after exercise endogenous opioids in the blood become elevated. This points to the possible role of opioids in behavioural regulation during and after exercise (Hoffman, 1997). Increase in plasma β-endorphin levels during long distance running has been correlated to changes in feelings of pleasantness after running (Wildman, Krüger, Schmole, Niemann & Matthaei, 1986). Other research however has failed to find a corresponding reversibility of mood state when inhibiting β-endorphins (Hatfield, Goldfarb, Sforzo & Flynn, 1987). In studies using animals, researchers have reported that there is an increase in level of beta endorphin in specific brain regions after exercise in rats (Balke, Stein & Vomachka, 1984). The analgesic, euphoric and addictive properties of opioids have been known for many years and it has long been accepted that they play an important role as neurotransmitters and hormones. In general it has been found that the involvement of opioid peptides increases with increasing intensities of physical activity.

Some research has been conducted investigating opiate concentration in blood during and after exercise. Forced prolonged swimming and acute running has been found to increase plasma beta-endorphin levels in animals (Metzger & Stein, 1984). It has also been found that in humans mild or moderate aerobic exercise (<60% of VO₂max) leads to changes, albeit only minor ones, in beta-endorphin levels in the blood (Goldfarb, Hatfield, Armstrong & Potts, 1991). After increased intensity of physical...
activity the majority of the research points to increased levels of plasma β-endorphin (Donevan & Andrew, 1987; Moughin, Henriet, Baulay, Hattom, Berthelay et al, 1988; Olehansky, Zoltick, Herman, et al, 1990). In most of these studies, peak values are reached within 15 minutes post-exercise and 1 hour after termination of the exercise beta-endorphin levels have returned to pre-exercise levels.

Although evidence presented here suggests endorphin and opioid systems are involved in physical activity and potentially related to the mood effects, it is unclear exactly to what extent and exactly how they are related. The endorphin hypothesis hence remains a distinct possibility, although evidence does not provide a clear enough picture to be able to emphatically state that this is the system by which exercise regulates and changes mood. Thoren, Floras, Hoffman et al (1990) warns that methodological problems with much of the research investigating the endorphin hypothesis may account for the lack of significant findings in terms of subjective changes in mood and increases in endorphin plasma level following physical activity. As with serotonin related research, further work is required to elucidate this relationship further.

2.6.3 The Norepinephrine hypothesis

As has already been stated elsewhere the anxiolytic effects of exercise have been linked to levels of norepinephrine (Morgan, 1985; Petruzello et al, 1991). Dishman (1996) provides an overview of how norepinephrine might modulate mood improvements, and specifically how it is related to the anti-anxiety effects of exercise. Research over many years has provided evidence for the link between availability of norepinephrine within the body and its link to euphoric and depressive mood states (Goodwen & Bunney, 1971). Samorajski, Rolsten, Przykorska and Davis (1987) also found increases in the level of norepinephrine after prolonged vigorous exercise. The first clinical studies investigating this hypothesis measured norepinephrine and its metabolites in urine. However due to the complexity of human biochemistry it is debatable how accurate this method is. Increases of the metabolites of norepinephrine have been found after exercise, although the relevance
of these particular norepinephrine substrates to the exercise and mood hypothesis remains unclear (Peyrin, 1990).

Animal studies have investigated this hypothesis although they generally report that exercise in rats does not effect levels of plasma norepinephrine (Cousineau, Ferguson, de Champlain, Gauthier, Cote et al, 1977; Peronnet, Cleroux, Perrault, Cousineau, de Champlain et al, 1981; Winder, Hagberg, Hickson, et al, 1978), although it has been noted that plasma norepinephrine levels may be imprecise estimates of synaptic activity (Chang, Kriek, van der Krogt & van Brummelen, 1991). Overall, Dishman (1996) concludes that if we are to truly investigate the possible connection between norepinephrine and physical activity we need to move beyond measuring levels of norepinephrine and its metabolites, to consider other issues, such as its synthesis and direct measures of neural activity. In his concluding remarks Dishman makes the point that the development of models should consider noradrenergic, serotonergic, dopaminergic and opioidergic neuron responses jointly rather than as separate single theories, hence potentially providing a more homogenous theory for the exercise and mood relationship.

2.6.4 Non-physiological theories of exercise and mood

Another possibility is that mood is increased, rather than through a biological system, but by a psychological mechanism. As has already been presented there is a large amount of research that has established the positive benefits of exercise on mood. Assuming this is the case, and the wealth of literature supports this assumption, then it seems a plausible possibility that the mechanisms responsible for these effects may be psychological in nature. Some of these theories are not strictly mechanisms for how exercise alters mood states, however they do provide a non-psychological insight into this relationship, and how people might use exercise in order to change mood. From this it may be possible to derive new theories, based on psychology and behaviour that might account for how exercise influences mood. Thayer, Newman and McLain (1994) conducted research examining the success of behaviours used to self-regulate negative moods, raise energy and reduce tension. Thayer et al reported the findings of four studies. Two of these studies used a fixed response questionnaire
to quantify behaviours, general strategies, and individual differences. The third study used professional judgements, in this case therapists, to determine predicted success of methods derived from participant’s responses. All studies reported a number of the same strategies participants reported they use or had used to regulate their own mood. A strategy consistently reported by participants was the use of exercise. Results suggested that exercise was one of the most used methods to control negative mood, although as no other research corroborates this evidence this may not be the case. Research validates the potential success of exercise as a method for improving mood and this is the first evidence to suggest participants actually use exercise for this purpose. Thayer et al (1994) postulated that this is a potential mechanism for how exercise and mood are related. Thayer concludes that mood is closely related with central states of general bodily arousal with conscious components of energy (and tiredness) and tension (as well as calmness). Thayer et al argues that exercise interacts with these dimensions and hence affects perception of mood after exercising.

These two dimensional models of mood have gained increased acceptance in recent psychological research as a potential explanation for the positive effects exercise has on mood. Hsioa and Thayer (1998) concluded that in general, moderate intensity exercise appears to have a primary mood effect of energy enhancement, a secondary effect of tension reduction and a tertiary effect of increased optimism. The authors believe that the more people exercise the more aware they are of positive mood effects, they confirmed this by asking experienced and non-experienced exercisers what their main reasons for exercising were. It was found that mood effects were a more common reason for exercising in experienced exercisers compared to non-experienced exercisers. Overall the mood regulation theory of physical activity is a plausible mechanism for the way exercise is used and conceptualised as a method to regulate mood. It remains an unlikely proposition however that that this can explain the mood enhancement effects of exercise in so many different investigations, as it would seem unlikely that everyone uses exercise as a mood regulating strategy.
2.6.5 Mechanisms: Conclusions

The mechanisms that have been proposed so far have failed to provide one universally accepted theory for the effects of exercise on mood, with a lack of conclusive evidence supporting any one particular theory. In terms of mechanisms that may be responsible for the mood effects of exercise there remains a number of feasible possibilities, including physiological and psychological mechanisms, however evidence for these mechanisms is often mixed, providing conflicting results. Morgan (1997) believes that the way to truly determine what mechanism might be responsible for exercise effects on mood is to abandon investigating just one of these possibilities and rather examine them together, in a multiple or synergistic way. Morgan however fails to explain how a methodology would attempt to do this. Most research only really mention them as possibilities, but provide no convincing arguments for one particular theory or another.

2.8 CONCLUSION

Overall the material presented in this chapter provides a picture of the state of exercise and mood research, with particular reference to issues of measurement, theory and limitations of previous research. It seems clear that there is a plethora of research providing evidence that points to the beneficial effects of exercise on health, mood, and psychological wellbeing. Although the evidence in this area is contradictory in places, and has methodological limitations, it seems clear that exercise as a potential therapeutic tool merits further investigation. Research has investigated duration and intensity limitations of exercise effects on mood. Overall evidence has been inconclusive, with conflicting findings and a lack of consensus amongst researchers. The majority of research suggests moderate intensity exercise is effective at causing positive mood changes, with some evidence supporting the same effect in lighter intensities and some research indicating vigorous intensities having the opposite effect. The duration of exercise required to exhibit these effects is also uncertain, although 10 minutes is generally held as needed to produce positive effects on mood. Although again conflicting evidence has been reported that suggests 5 minutes also can produce significant effects on mood.
Recent research has attempted to provide psychological and physiological explanations for these affects, perhaps with debatable success. The relative difficulty in conducting research into specific physiological and neuro-chemical systems makes it difficult to determine factors that mediate the response between mood and exercise. At this stage it remains the case that a number of hypotheses seem viable, i.e. Endorphin, Serotonin, and mood regulation for example. The lack of evidence supporting these theories is a major limitation of current research.

At this point it certainly seems desirable to attempt to use exercise within a health setting, or within a particular population that could potentially benefit from the positive psychological effects of exercise. One such population is smokers, in particular those smokers who wish to quit. Many of the symptoms commonly associated with smoking withdrawal are mood constructs reported to be affected by exercise. As such exercise may provide a potential mediating effect for the nicotine withdrawal syndrome. The next chapter will outline what research has been conducted in this area.
CHAPTER 3

SMOKING AND EXERCISE: RESEARCH AND CURRENT THEORY

3.1 INTRODUCTION

Evidence presented so far has discussed the effects of smoking on biological, physiological and psychological mechanisms. In particular the consequences and psychological implications for individuals who give up long term cigarette use have also been examined. Literature concerning the consequences of exercise for individuals in both a physical and psychological sense has also been critically analysed. This chapter will focus on research that has attempted to integrate these two fields, as it remains a possibility that exercise might be useful in a smoking cessation context. There are a number of issues that are pertinent to this area, some of which arise from issues concerning the nature and methodology of studies investigating the relationship between smoking and exercise.

3.1.1 Relationships between smoking and exercise behaviour

Research has been conducted examining the relationship between smoking and exercise behaviour in a general sense, as opposed to direct experimental manipulations of these behaviours. For example, research in the fields of public health and medicine suggest that smokers are less likely to exercise (Coulson, Eiser, & Eiser, 1997; Patterson, Haines, & Popkin, 1994). Other research has also found a similar inverse relationship between smoking prevalence and exercise (Gibbons, Blair, Cooper & Smith, 1983; Yamamoto, Yano & Rhoads, 1983; Zunich & Dickinson, 1979). Koplan, Powell, Sikes, Shirley and Campbell (1982) found in a random sample of runners in a large road race a marked reduction in smoking in those who smoked prior to taking up running. In this group 81% and 75%, of men and women respectively stopped smoking when they took up running.

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Available evidence has suggested that smoking behaviour in adolescents is associated with minimal involvement in health enhancing behaviours, which includes involvement in exercise and general physical activity (Kulbok, Earls, & Montgomery, 1988; Nutbeam, Aaro, & Catford, 1989). In adults this association has also been found with smoking being associated with decreased levels of physical activity (Klesges, Eck, Isbell, et al, 1990). Hickey, Mulcahy, Bourke, Graham and Wilson-Davies (1975) assessed physical activity (structured exercise), leisure activity and work related physical activity, in a sample of over 15 thousand men aged between 25-74 years. In men under 60 Hickey et al found that there was a significant negative association between leisure activity and cigarette smoking. This evidence suggest that the more physically active participants smoked less, and were more likely to be non-smokers or ex-smokers. Using a similar survey methodology Coulson, Eiser and Eiser (1997) measured smoking status and exercise behaviour in adolescents, from 12 to 15 years old. Results indicated that there was a significant inverse relationship between smoking and exercise.

This evidence however is not without its problems. Measures used within these studies, and many others in this area, use very brief questions to determine smoking and exercise status. This is a potential problem with the data as it is difficult to be completely confident in self-reported levels of smoking and exercise, although the consistent finding of this relationship, between different studies using different methodologies, suggests that the results may be reliable. Marti and Vartiainen (1989) examined the association between frequency of leisure time exercise and smoking, as well as other cardiovascular disease risk factors in a sample of adolescents. After medical examination, self-administered questionnaire, parental questionnaires and blood tests it was found that leisure time exercise was inversely related to daily smoking, and that self-reports and other measures of smoking and exercise behaviour were significantly related. This suggests self-reported smoking and exercise behaviour can be accurate.

Morgan (1979) conducted a postal study to determine exercise performance and the smoking behaviour of members of a running club. Morgan and colleagues reported
that of the 141 members of the club, 35 had been smokers when they originally joined, with only three of these continuing to smoke once they had been a member for a month. Other work by Hickey, Bourke, Grahame and Wilson-Davies (1975) found the same inverse relationship in men reporting their work and leisure activities, although findings were based on retrospective self-reports of smoking and exercise behaviour and therefore are prone to recall bias. Despite this, evidence discussed suggests that exercise might reduce smoking, although from this type of evidence one cannot really comment on how this might occur or what mechanisms may be involved. As data is relational it is also impossible to discern cause and effect from these results.

Faulkner, Bailey and Mirwald (1987) published results from a study that attempted to address the methodological problems associated with this type of survey data. Again investigating the relationship between smoking and physical activity Faulkner et al researched this issue in a large sample. From this sample was selected a sub-sample, this group was chosen via the match between participants self-reported physical activity and measured physical fitness, using VO₂max exercise threshold levels. This allowed validation of participant self-reported physical activity level, hence controlling for the classification of participants on self-reported measures alone. It was found there was a significant association between lower smoking rates with increasing levels of physical activity. Interestingly there was also a significant association between increasing physical activity and number of quitters, these being defined as having quit permanently in the past 9 years. Hence increasing physical activity was significantly related to number of ex-smokers. Faulkner et al therefore concluded that physical activity may have a role to play in smoking cessation programmes, although it may just be that smokers who quit decided to become healthier in general, which includes increasing levels of physical activity.

The primary aim of future research into smoking and exercise should be to determine the specifics of this relationship, in particular what are the effects of specified, controlled amounts of exercise upon smokers mood, and on specific common nicotine withdrawal symptoms in smokers attempting to stop smoking. What is
required is a better understanding of the duration and intensities that may be required to exhibit positive effects, what mechanisms are involved in this relationship and how best to implement these into specialised, smoking cessation programmes. The following sections will outline what is already known about these issues, and how research can potentially provide further answers and a greater understanding of this relationship. Before going on to this however the following section will address specific physiological effects of smoking on exercise performance and ability.

3.1.2 The Physiological effects of smoking on exercise performance

How smoking actually effects physical activity and performance is important in the field of exercise and smoking research as it may have implications for the types, and durations of exercise that smokers can actually do. Huie (1996) conducted a review of the research specifically looking at the effect smoking has on exercise performance. It was reported smoking appears to effect endurance ability, with significantly more smokers being slower at completing exercise, failing to meet their 85% increase of age predicted heart rate, and exhibiting blunted cardiovascular responses compared to non-smokers. A study by Perkins, Sexton, Solberg-Kassel and Epstein (1991) found that young smokers, who smoked on average 15 cigarettes per day, had significantly higher ratings of perceived exertion when performing light intensity exercise compared to non-smoker controls. Others have found that smokers end exercise sessions twice as soon as non-smokers due to symptoms of fatigue, exhaustion and shortness of breath (Gordon, Leon, Ekelund, Sopko, Probstfield et al. 1987). Also smokers have been found to run slower than non-smokers during fitness tests (Conway & Cronan, 1992; Marti, Abelin, Minder & VADER, 1988).

Huie and others propose that this detriment in exercise performance is due to changes induced by long-term nicotine exposure on the sympathoadrenal system, such changes being mediated through a systematic down regulation of β-adrenergic receptors. The effect on aerobic capacity appears to be a little less clear, with conflicting results pointing to lower capacity, and others to no difference. This in part may reflect the established theory that maximal aerobic capacity is, at least to some extent, determined genetically. The intake of Carbon monoxide (CO) is a prominent
feature of smoking and this has a specific effect on exercise in smokers. Investigations have led researchers to believe that CO adversely affects aerobic capacity by interfering with oxygen carrying capacity. As smokers have been found to have heightened levels of CO (Jarvis, Belcher, Vessey, & Hutchinson, 1986) this in turn will effect available oxygen, which will have an impact on exercise performance. From this area of research it seems smoking results in impaired endurance capacity, decreases in VO_{2max}, and it appears energy expenditure may be greater whilst smoking compared to exercising while having stopped smoking (Perkins, Epstein, Stiller, Jacob & Marks, 1989; Perkins, Epstein, Stiller, Marks & Jacob, 2004).

Evidence suggests that smoking has a negative impact not just on physiological health, but capacity to exercise and level of exercise performance as well. This all suggests that smokers may have less ability to perform high intensity exercise, and exercise for long durations. Huie (1996) reported that studies examining the effect of nicotine on metabolism found a significant increase in resting metabolic rate (RMR). In those who had just been exposed to nicotine via nasal spray it was found they had a higher degree of energy expenditure during exercise, in fact double the energy expenditure compared to participants in the control condition. This influences energy used during exercise and hence may explain smokers reduced capacity and endurance during exercise. Conway and Crohan (1992) examined the association between exercise activity, smoking behaviour and physical fitness in a large survey sample. It was found that smoking was associated with lower levels of physical activity and lower physical endurance, both in terms of cardiovascular fitness and muscular strength. Findings indicated that participants who were current smokers engaged in fewer exercise sessions per week, those who did exercise did so for shorter time periods and expended fewer kilocalories per week in exercise activities compared to ex-smokers and those who had never smoked. Other studies have also indicated that smoking is detrimental to readiness to exercise even among relatively young and fit participants (Bahrke, Poland, Baur & Connors, 1988; Biersner, Gunderson & Rahe, 1972; Conway & Cronan, 1988; Jensen, 1986).
Sidney, Sternfeld, Gidding, Jacobs, Bild et al (1993) examined cigarette smoking and exercise test duration in young adults, graded exercise on a treadmill was performed by participants. It was found that mean exercise test duration of smokers compared to non-smokers was between 29 and 64 seconds shorter. Also the mean duration of heart rate to 130 beats per minute in smokers took 20 – 50 seconds longer than non-smokers. The authors concluded that smoking appears to blunt heart rate response to exercise, so that exercise duration to sub-maximal heart rate is actually increased in smokers even though maximal performance is impaired. This is an interesting finding, as this may make smokers appear fitter than they actually are due to there heart rate not being as responsive to exercise compared to non-smoking matched controls. This has also been suggested to be the case in other research (Crow, Rautaharju, Prineas, Connett, Furberg et al. 1986).

This evidence certainly suggests that smoking status should be considered in the interpretation of fitness assessments in smokers where sub-maximal exercise tests are utilised or else the fitness of smokers is likely to be overestimated. This research shows the detrimental effects smoking appears to have on exercise performance. Along with this research there are a plethora of findings that show exercise and smoking behaviours to be inversely related. However from this work one cannot determine how or why this relationship occurs. This remains to be determined by further research.

### 3.2 EXERCISE AND SMOKING RESEARCH

Evidence suggests that exercise increases positive mood and decreases the severity of many of the symptoms associated with common tobacco withdrawal (Maroulakis & Zervas, 1993; Martinsen & Morgan, 1997; Petruzzello & Landers, 1994). The physiological benefits of regular exercise are well documented, with physical fitness being inversely related to mortality due to cardiovascular disease and most types of cancer (Batty, Shipley, Marmont & Davey, 2002; Blair, Kohl, Paffenberger, Clark, Cooper et al. 1989: Brown, Balluz, Heath, Moriarty, Ford et al, 2003; Foy, Rejeski, Berry, Zaccaro & Woodard, 2001; Paffenberger, Wing & Hyde, 1978).
that presents itself is can exercise be beneficial for smokers attempting to quit? Evidence reported previously suggests that smoking and exercise, at the very least, are inversely related, which may suggest that exercise in some way may decrease smokers urge and need to smoke. This association however may just be the fact that smoking impairs exercise ability, hence smokers stop smoking in order to do exercise rather than exercise making smokers stop.

It would appear that the possible benefits of smokers using exercise to aid cessation would be high, with not only potential decreases in withdrawal symptoms but also improvements in overall physiological health. However before exercise can be implemented as a cessation aid in any practical sense, a number of key issues need investigating. Specifically what intensities and durations of exercise are required to have a positive effect, and how best to implement this as a health intervention? A body of literature does exist that has examined exercise and smoking directly, and attempts have been made to elucidate a number of the important issues. As this research consists of quite different methodologies, it seems appropriate here to describe first studies that use long term exercise interventions and then move on to acute exercise intervention studies. From this review of the current literature it should be possible to determine what new research is required in this field, and how methodological problems inherent in some of this previous research can be addressed in future investigations.

3.2.1 Exercise and smoking research: Chronic exercise interventions

Research has been conducted specifically examining the possible use of long-term exercise as a smoking cessation aid, however research in this area has provided somewhat mixed findings. For example Russell, Epstein, Johnston, Block & Blair (1988) found no difference in smoking cessation in groups of smokers receiving social support for smoking abstinence plus a programme of exercise over an eight week period. The methodology involved smokers who attended a smoking cessation group either receiving extra contact control time, taking part in extra smoking habit change classes or a physical activity programme. Russell et al reported no difference in abstinence success recorded over an 18 month period across groups. From this
study it would seem that exercise did not add anything to abstinence rates, perhaps suggesting that exercise is not useful in a smoking cessation context. However over the study duration abstinence was alone used to infer the usefulness of exercise, no direct measures of exercise effects on withdrawal were taken. As such it would seem inappropriate to dismiss the use of exercise as a cessation aid on this evidence alone.

Other studies however have also failed to find a significant relationship. Boanno and Lies (1974) for example engaged 19 smokers in a 12 week supervised exercise programme of walking and jogging. No smoking cessation was enforced in the study, rather the aim of the research was to determine if such an exercise programme had a natural reducing effect on cigarette consumption. It was found that no participants in either the exercise condition, or the no exercise matched control condition stopped smoking or lowered the number of cigarettes smoked. Engs and Mulhall (1982) investigated smoking habits of undergraduate students before and after a 15 week course requiring either strenuous activity or non-aerobic activity (such as snooker and darts). No pre- to post-programme changes were found for participants in either group. The samples used within these two studies were not particularly representative of the population of smokers as a whole, as these studies were designed for CHD patients and students. Consequently most of the participants were coronary-prone men who had been changing other lifestyle behaviours in addition to physical activity. Changing multiple health behaviours may be problematic (Boudreaux, Francis, Taylor Scarinci & Brantley, 2003) and therefore may explain the lack of significant findings. Also the frequency, duration and intensity of physical activity were self reported, and rate of adherence to exercise were not reported in either of these studies, therefore it is problematic drawing conclusions from these results.

Hill (1985), in a similar investigation, found no improvements in abstinence in a group of smokers engaged in an exercise program. Hill’s methodology involved 36 participants taking part in a standard, twice weekly smoking cessation group (lasting five weeks). The experimental group also participated twice weekly in an exercise programme with the control group having equal contact time. Exercise involved 30 minutes of aerobic physical activity and participants were also encouraged to engage
in physical activity when they felt like smoking, anytime during the week. A disadvantage of this study was that exercise intensity was not recorded and only self-report measures of weekly activity were taken. This makes it impossible to say with any degree of certainty what intensity parameters participants were exercising within, and if their reports of physical activity outside the cessation programme were accurate. Certainly without verification via other means, this remains a major disadvantage with this research. Also in Hill’s study participants were required to only do supervised activity once a week and no direct withdrawal symptom measures were taken during this exercise, hence any reductions in smoking withdrawal during exercise could not be observed. Russell et al’s (1998) study suffers from similar methodological problems.

Albrecht, Marcus, Roberts, Forman and Parisi (1998) evaluated a randomized prospective trial of the potential effects of a vigorous exercise training programme alongside cognitive behavioural therapy (CBT) for smoking cessation, compared to CBT with exercise education lectures. Exercise consisted of 12 weeks of 3 sessions per week of vigorous intensity exercise, averaging 83% of maximum heart rate achieved on their baseline, resting heart rates. Results indicated that participants who had undergone the exercise training had significant improved exercise performance, but no difference in rates of cessation were observed. In a similar study examining the use of exercise in sedentary female smokers Marcus, Albrecht, Niaura, Taylor, Simkin et al (1995) reported more favourable results. The authors implemented a supervised exercise programme over a 15 week period. Exercise treatments involved three supervised exercise sessions per week, the exercise being of moderate to vigorous intensity in each session. Contact controls involved three health awareness lectures per week. Results indicated that exercise training improved short-term cessation rates, which in itself suggests using exercise alongside a smoking cessation programme may prove a useful strategy for increasing short-term maintenance of smoking cessation.

Some unpublished work has also attempted to assess the effects of exercise in treatment for smoking. Johnson, Rosenbaum, Framer and Wildman (1979) assessed the influence of an eight week exercise programme on cigarette consumption and
physical fitness. The study compared the effects of two exercise programmes, the first involving 30 minutes of walking per day, with the second consisting of an incremental programme of walking increasing in duration and intensity. In addition to these exercise programmes participants received behavioural smoking counselling and relaxation training. Results indicated no differences in smoking between the groups at either post-treatment or follow up, however participants in both programmes did significantly reduce their cigarette consumption. Although this study showed no differential effect of the two programmes this might be expected as multiple cessation treatments were used as well as exercise, making separate assessment of the effects of exercise on smoking impossible.

Howley, Callahan and Yaeter (1980) attempted to investigate the separate, and combined, effects of exercise and self-management strategies on smoking cessation. Participants in the exercise condition followed an individualised exercise programme including walking and running which was gradually increased in terms of duration and intensity during the study. A self-management group included participants learning self-control procedures for dealing with smoking situations. A third condition involved both exercise and the self-management programme. Results indicated that all three experimental groups significantly reduced their smoking rate, and that there were no differences in the groups at 6 weeks or at 12 months. This study suffers from similar methodological limitations as previous research, in particular over-reliance on self-report measures and specifically the fact no withdrawal measures were used. Because of this it is not possible to determine if exercise affects smoking withdrawal symptoms at all. Other researchers have attempted to address some of these problems.

Bock, Marcus, King, Borrelli, and Roberts (1999) examined both the acute and chronic effects of vigorous exercise on affect, nicotine withdrawal and desire for cigarettes. The study included an exercise and contact control condition, exercise consisted of three sessions per week for 12 weeks of a vigorous exercise programme. This equated to three 45 to 60 minutes supervised exercise sessions per week, performed in an intensity range between 60 – 85 % of HRR (this is vigorous intensity exercise). Withdrawal was measured before and after these exercise sessions. Bock et
al observed a significant reduction in negative affect, withdrawal symptoms and desire for cigarettes following exercise in most weeks of the programme. At the end of the 12 week period no chronic changes were observed in desire to smoke and withdrawal from baseline. This suggests that vigorous exercise produces acute improvements in withdrawal symptoms in a group of participants attempting to abstain from nicotine use, but does not appear to have longer term positive effects. Due to the nature of nicotine withdrawal, specifically the time course of withdrawal, it is maybe not so surprising that exercise appears to only produce transient, acute improvements in withdrawal. Research has identified a number of common symptoms that seem to accompany smoking cessation (for example Parrott, Garnham & Pincock, 1996) although the inconsistency of the symptoms that do occur seems to be a prominent feature of the withdrawal syndrome (Hughes, Gust, Skoog, Keenan Fenwick, 1991). It may well be the case that exercise will be best used in attempting to reduce withdrawal in the first week of cessation, as generally more symptoms are present in this period and secondly, symptoms are at there most severe in the majority of cases. Certainly from the evidence presented so far it is difficult to extrapolate what long-term effects exercise may have on withdrawal symptoms and desire to smoke.

Jonsdottir and Jonsdottir (2001) utilised a similar methodology to that previously described to compare two smoking cessation programmes over a period of a year. One programme consisted of cessation meetings, with an equivalent cessation programme including exercise as well. This exercise consisted of supervised exercise sessions three times a week in the first three months, then the next four months after the cessation counselling finished the same minus the exercise specialist (i.e. participants led the exercise groups themselves). Results indicated that there were no significant differences between the two groups in terms of abstinence, although the authors did report a non-significant trend in relapse free abstinence time in the exercise group. Although this study showed no real significant effect of exercise a number of problems with the research make the conclusions from the study unreliable. Perhaps the most important is that the two cessation programmes were actually quite different, occurring in different places, with different cessation specialists and different economic costs for the participants taking part. This may
explain why only a trend in the data was observed rather than a significant difference.

Marcus, Lewis, King, Albrecht, Hogan et al (2003) investigated the use of moderate intensity physical activity in female smokers who wished to quit smoking. The methodology involved sedentary female smokers who were randomized to either eight weeks of treatment followed by a 3 and 12 month follow up. Treatment incorporated a CBT based smoking cessation programme plus moderate intensity exercise compared to the same treatment plus contact control. Exercise involved one supervised exercise session per week and participants were also able to have supervised gym sessions on two or more occasions per week. Overall during weeks one and two participants were instructed to participate in 105 minutes of exercise, this increased to 135 minute in week 3 and then 165 minutes for the remainder of the study.

Vigorous exercise has been predominantly used in previous investigations of exercise and smoking, Marcus et al’s study presents a trial that uses moderate rather than vigorous intensity exercise. This intensity of activity is an intensity of exercise that it is felt the average smoker could actually do. This study also represents the only randomized control trial comparing the efficacy of a behavioural programme with exercise in terms of both supervised and home delivered exercise sessions. Marcus, Lewis, Horan, King, Albrecht et al (2004) presented the preliminary findings for this research, which indicated that those participants in the CBT plus exercise group were more likely to be abstinent from smoking at a 3 month follow up, however differences were not seen between this group, or the CBT alone group, at 8 week and 2 month follow up. From these results the authors suggest that moderate intensity exercise may be an effective adjutant to CBT for smoking cessation, they also argue that moderate intensity exercise is a more disseminable form of physical activity that can be performed by smokers, more so than vigorous intensity exercise which may require medical supervision. The fact no significant differences between groups were seen at a 8 and 12 month follow up but were at 3 months is a finding difficult to explain, and the authors provide no explanation why this was found.
Studies have also investigated the efficacy of exercise counselling in long term smoking cessation interventions. For example Ussher, West, McEwen, Taylor and Steptoe (2003) examined whether exercise counselling increased exercise and smoking abstinence, and reduced tobacco withdrawal symptoms, in a community based stop smoking clinic. Participants were randomly assigned to a 7 week smoking cessation programme, including nicotine replacement therapy (NRT) plus either exercise counselling or health education with equal contact time. Exercise counselling consisted of participants receiving an initial 5 minute session of CBT exercise counselling incorporating a number of things, i.e. goal setting, relapse prevention planning and self-monitoring. Participants were encouraged to use exercise as a self-control strategy for reducing desire to smoke and withdrawal symptoms. From the second week onwards exercise levels in the previous weeks were reviewed and encouragement was given towards maintaining exercise increases. Participants were encouraged to engage in 30 minutes of physical activity on at least 5 days per week, of a moderate intensity (which is in line with ACSM guidelines). Physical activity was assessed via self-report methods at baseline, and after 1, 4 and 6 weeks. Participants were also required to measure and record their radial pulse after each exercise session each day, this was then used to categorise intensity of exercise, as calculated by the investigators using heart rate reserve (HRR; Karvonen & Vuorimaa, 1988).

Tobacco withdrawal symptoms were recorded at participants first visit at smoking groups, then at each subsequent visit. Symptom items included stress, tension, anxiety and depression, as well as desire to smoke. Analysis of data revealed that there were no differences in smoking abstinence between the exercise group and the control group. Those in the exercise group did report an increase in level of exercise, and those in the exercise group reported less tension, stress and anxiety compared to the controls during the first week of smoking abstinence, less irritability in the second week and less restlessness throughout the three week abstinence period. The authors hence concluded that adding such an exercise counselling programme to smoking cessation groups can produce benefits in smoking related withdrawal symptoms. From this study exercise seems partly useful, although it really only
demonstrated modest reductions in withdrawal and had no significant effect on overall abstinence rates. The study suffers from self-report bias as exercise was based on unsupervised sessions, with no independent validation or physiological marker of how much exercise participants were actually doing. Radial pulse was recorded by participants however this measurement was not verified by experimenters so its accuracy is unclear at this stage.

Overall research investigating long term exercise programmes have provided some positive findings, evidence does seem to suggest that exercise may be useful in increasing abstinence effect at the end of cessation programmes and also in potentially decreasing smoking withdrawal symptoms and desire to smoke. However due to the nature of these investigations it remains difficult to determine anything more about this relationships. Few studies actually measure withdrawal symptoms and desire to smoke during and immediately after exercise. Also the relationship between decreases in withdrawal symptoms and increases in abstinence remains unclear. Because research has provided somewhat mixed results it still remains to be determined if exercise effects withdrawal at all, and if so when this positive effect happens. Also few studies actually postulate any mechanisms to suggest how this effect may occur. The investigation of how exercise might influence smoking status in the long term is certainly a valid avenue of research, however it may be that some of the fundamental aspects of this relationship require investigating in an acute sense before this type of investigation is undertaken. It is also unclear from the above research how exercise should be implemented in smoking cessation programmes, for example some evidence suggests this should occur from the beginning of cessation clinics (Patten, Vickers, Martin & Williams, 2003). The following section will outline what research has been done investigating the acute effects of exercise on smoking withdrawal and abstinence.

### 3.2.1 Exercise and smoking research: Acute exercise interventions

A notable difference between short term and long term exercise intervention in smokers is that success in the latter is often based on cessation and abstinence rates, whereas predominantly in the acute research it is concerned with reducing
withdrawal symptoms and desire to smoke. For example Pomerleau, Scherzer, Grunberg, Pomerleau, Judge et al (1987) examined the acute effects of aerobic exercise on smoking behaviour. The study involved 10 smokers who smoked as normal until the testing period. Participants then had a 30 minute rest period (in which they did not smoke), followed by 30 minutes of exercise, either of vigorous intensity (which equated to 80% maximal oxygen uptake (VO2max) or light intensity (approximately 30% VO2max). This light intensity condition was postulated as simulating a normal daytime activity level. Pomerleau et al monitored both physiological and biological changes during and after the exercise. These included mean work output, heart rate, lactic acid as well as the measurement of hormones (norepinephrine, epinephrine, immunoreactive beta-endorphin and cortisol). The Shiffman withdrawal scale (Shiffman & Jarvik, 1976) was administered before and after exercise in order to determine withdrawal symptoms. In terms of plasma nicotine levels no significant differences were found in smoking after the exercise condition, perhaps suggesting acute vigorous intensity exercise does not effect nicotine metabolism. Pomerleau et al did however report a general decrease in desire to smoke amongst participants after exercise. It is this finding that is of most interest as it is one of the first acute studies to provide direct evidence that acute exercise may reduce desire to smoke. The study however suffers from insufficient sample size (only 10 participants took part in the study) and as such it is difficult to extrapolate these findings further. As there were no differences in plasma nicotine following exercise this may suggest that exercise does not effect nicotine metabolism and as such changes in metabolic rate after exercise may not be responsible for reductions in desire to smoke. Further research is required to assess the role nicotine metabolism may play in this relationship.

Other authors have also attempted to determine if acute exercise can have beneficial effects upon smoking withdrawal symptoms. Grove, Wilkinson and Dawson (1993) investigated the effects of exercise on certain correlates of smoking withdrawal, for example depression and stress, and found some positive effects. The methodology involved 13 female smokers half of which completed one 15 minute period of daily vigorous intensity exercise (between 60 and 80% of HRR) on a stationary ergometer. Measured variables included resting heart rate, weight, sleep, desire for cigarette and
mood. Participants provided a week of baseline measures for comparison to the exercise period. After this participants were told to cease or substantially reduce their smoking, measured via self-report measures and nicotine plasma levels. Participants in the exercise condition reported desire to smoke was reduced, as were scores on the confusion subscale of the Profile of Mood States (POMS; McNair et al, 1971). The validity of this research is however reduced due to its small sample size, with only 13 participants it is difficult to be completely confident in Grove et al’s findings. On a positive note however the authors do point to the positive effects of exercise on smoking withdrawal and desire to smoke. This research seems to suggest that whilst continuing to smoke completing a short bout of vigorous intensity exercise daily reduces number of cigarettes smoked, as well as desire to smoke.

Other researchers have investigated short durations of moderate activity on smoking behaviour. Thayer, Peters, Takahashi and Birkhead-Flight (1993) compared the effects of a short bout (5 minutes) of moderate intensity exercise on mood and affect in smokers who had been acutely abstinent from smoking, and participants who frequently snack on high sugar foods. Thayer et al’s methodology involved 16 participants performing over 12 occasions walking briskly or being sedentary for a 5 minute period (this was randomly allocated). After the 5 minute period participants were asked to rate their desire to smoke and mood. A second experiment was run using the same methodology but this time with frequent sugar snackers, asking them after each 5 minute bout of exercise if they had a desire to eat. Thayer et al hypothesised that different methods of modulating mood can be interchangeable, hence where smoking or sugar snacking was used to regulate mood exercise might be a substitute for this. The two experiments were run in order to test the proposition that exercise would simultaneously increase energy and reduce urge to smoke. Results from both experiments indicated that short walks of moderate intensity produced increases in feelings of energy and reduced the urge to smoke in smokers, as well as the urge to eat in frequent sugar snackers. The exercise also significantly increased the time until the next cigarette was smoked or the next snack eaten. Thayer et al concluded that the similarity of the suppression of the two behaviours, quite different behaviours one might argue, is notable as it may indicate evidence for Thayer et al’s theory of mood regulation. That is, increased energy and reductions in
tense arousal can occur due to short bouts of low to moderate intensity exercise, which in turn Thayer et al argues is related to reductions in smoking behaviour.

This research provides evidence that indicates exercise can reduce urge to smoke via short, acute bouts of moderate intensity exercise. The study provides further evidence that exercise may be beneficial in reducing desire to smoke in smokers, and this experiment is the first to attempt to use a naturalistic, as opposed to a lab based exercise procedure to demonstrate this. Smokers have to be realistically able and willing to do exercise and before exercise can be prescribed as a cessation aid this must be investigated empirically. The fact Thayer et al employed only a 5 minute bout of exercise within the methodology of the study and still found significant reductions in withdrawal might suggest that 5 minutes of exercise is sufficient, and also may be more acceptable to smokers. It seems feasible that the majority of smokers would be able to complete 5 minutes of light to moderate intensity exercise to help reduce desire to smoke.

A number of different methodologies have been employed investigating acute exercise and smoking withdrawal. One of the problems with this area of research, in both acute and long term studies, is that due to this variety of methodological designs employed it is difficult to obtain consistent results on exercise effects on smoking withdrawal. It seems that it may well benefit this area of research if a more consistent approach to investigating this phenomenon was employed by exercise and smoking researchers. Ussher, Nunziata, Cropley and West (2001) recently conducted a strictly controlled study in order to determine if ten minutes of moderate intensity exercise significantly reduced common smoking withdrawal symptoms and desire to smoke. Participants were self-reported sedentary smokers, who had been abstinent from smoking from between 12-15 hours. Ussher et al compared ten minutes of moderate intensity exercise with two control conditions, a passive and an active control condition, which involved watching a neutral video. Mood was assessed prior to the exercise condition, during the exercise condition and at three five minute intervals after the conditions. This was an attempt to establish the durational effects of 10 minutes of moderate intensity exercise on smoking withdrawal symptoms and desire to smoke. Results indicated that the control conditions were not sufficient to have
any effect on withdrawal symptoms as active and passive controls withdrawal symptoms were not significantly different over time. However in the moderate exercise condition significant reductions were observed over all major symptoms (including depression, stress, difficulty concentrating and tension) and desire to smoke during exercise and during the fifteen minute post exercise period. In fact symptoms had not returned to post-exercise, base line, levels at the last (15 minute) testing point. This evidence suggests that exercise of moderate intensity and short duration is effective in reducing common withdrawal symptoms and desire to smoke.

This study was methodologically more rigorous than previous research. It also incorporated measures that have been used extensively to measure withdrawal (West & Russell, 1985). This studies particular strength is in the way withdrawal was measured, in the sense that it was measured throughout the exercise condition. By doing this a perspective on when changes in withdrawal symptoms actually occurred, and how long they lasted, was obtained. Previous research failed to do this, and this is one of the first studies to attempt to explore the reported changes in withdrawal following exercise. Overall Ussher et al’s study provides convincing evidence for the positive effects of acute exercise on smoking withdrawal symptoms and desire to smoke.

Other research has investigated different types of physical activity and effects on smoking withdrawal. Ussher and West (2004) investigated whether brief isometric exercise (this involves simple slow movements, wherein muscles exert pressure on other muscles) similarly reduces desire to smoke and withdrawal symptoms as moderate intensity aerobic exercise has been found to. Following approximately 17 hours of abstinence smokers were randomised to five minutes of either seated isometric exercise, seated focusing on muscle groups or seated passively. Ratings of withdrawal symptoms were measured, with desire to smoke and withdrawal symptoms rated at baseline, immediately after the conditions, then at five, 10, 15 and 20 minutes post-intervention. These were measured using a single item withdrawal measure (West & Russell, 1985). Findings indicated that isometric exercise produced a greater reduction in desire to smoke compared with control at immediate post-intervention and at five minutes post-intervention relative to baseline. These results
suggested a brief routine of seated isometric exercise may be useful for managing desire to smoke in abstinent smokers. The authors suggest this benefit is likely to be short lived, lasting no more than five minutes, but may be sufficient for immediate relief from strong urges to smoke. Isometric exercise is fundamentally different from the aerobic exercise interventions predominantly used within this area of research. The fact that Ussher et al found that isometric exercise reduced withdrawal symptoms and desire to smoke, albeit only briefly, might suggest that any form of physical activity has the potential to reduce withdrawal. It might also suggest that distraction from desire to smoke is sufficient to produce these differences, as has been suggested in exercise and mood research (Raglin & Morgan, 1987).

3.2.3 Exercise and smoking research: Conclusions

In a review of the research literature in this area, of both acute and chronic studies, Ussher, West, Taylor and McEwen (2000) concluded that although there were a number of studies looking into the effects of exercise on smoking withdrawal symptoms all but one (Marcus et al, 1999) had sufficient sample size and experimental rigor to draw valid conclusions. Ussher et al concluded that trials that did not show an effect of acute exercise on smoking withdrawal symptoms and desire to smoke were too small in terms of sample size to exclude reliability issues, and they also had other methodological limitations. Ussher et al argues that further trials are needed to explore this relationship more conclusively. Other researchers have conducted similar reviews of this research and have formulated similar conclusions. Nishi, Jenicek and Tatara, (1998) reported that due to the small number of studies, and the small size of samples within these studies, effects remain unclear. This review however contained fewer studies than Ussher et al's (2000) more recent review, and hence is more limited in its scope and conclusions.

Despite the evidence into the acute and long-term effects of exercise there are still a number of fundamental issues about this relationship that need to be addressed further. Crucial issues include whether shorter durations and intensities of exercise are still as effective as 10 minutes of exercise, some evidence has suggested this may be the case but further studies are required to confirm these findings. Also the
intensities of exercise required to exhibit these reductions in withdrawal need to be addressed. What mechanisms that are involved in the effect also remain unclear, and few researchers propose what these may be. Overall acute studies have shown that moderate intensity exercise appears to be effective at reducing withdrawal and the urge to smoke. As withdrawal may be related significantly to cessation success then the fact exercise appears to reduce withdrawal merits further investigation.

3.3 USING EXERCISE AS A SMOKING CESSATION AID

Another issue that remains unanswered at this stage is exactly how a population of smokers might respond to using exercise as a means to aid cessation. Preliminary research by Ussher et al (2004) suggests the response from smokers in respect to using exercise to help smoking abstinence may be favourable. Research investigating the demographic distribution and socio-economic status of smokers may provide some indication also of the way smokers might react to using exercise in this way. The government white paper ‘Smoking Kills’ (1998) and the Department of National Statistics paper ‘Smoking related behaviour and attitudes’ (2002) states that, in general, people in the manual socio-economic groups (SES) are more likely to smoke than those in non-manual groups. The differences are even greater when looking at the differences between all SES groups. For example in the professional group 15% smoked compared to 42% in the manual group. Clearly the distribution of smokers across the SES spectrum is not equal. This has implications for exercise prescription as members of lower SES groups are predominantly more sedentary (Scully, Kremer, Meade Graham & Dudgeon, 1998), they generally engage in less exercise behaviour and have more illness that may impact on the ability to do exercise. This in turn it is believed is likely to have an impact on how smokers use exercise in a smoking cessation context.

Other research has shown that SES is related to exercise behaviours. Wister (1996) examined the effects of SES on health behaviour, in particular smoking and exercise behaviour by performing regression analysis on a 1990 health promotion survey. Results indicated that SES appears to effect health behaviours in important ways, in
particular the effects of SES on health behaviour appeared to be greater in young and middle-age groups compared to older age groups. Income was found to be inversely associated with smoking at all age groups, and education, age and income were also associated with level of physical activity. Education was found to exert the most consistent effect on health behaviour, particularly smoking and physical activity level. Wister posits one explanation for this finding may be that exercise, and smoking to a lesser extent, tend to be more influenced by health knowledge, health beliefs, and health values (as measured by education and work status) than by materialist or financial conditions (as measured via income). Whether this is the case or not, this research suggests smokers engage in less physical activity in general, both in terms of formal exercise and informal physical activity.

Studies that have investigated smoking and exercise have predominantly used quite long exercise programmes of above moderate intensities. For example Bock et al (199) used an exercise programme consisting of three sessions per week, for 12 weeks of a vigorous intensity exercise. That is three 45 to 60 minutes supervised exercise sessions per week. As the above statistics illustrate smokers have less time, money and inclination to take part in rigorous exercise regimes (Wiser, 1997), as has also been found to be the case in females of lower SES (Jeffrey & French, 1996). Prescription of such intense exercise to such a group does not seem appropriate and it is predicted uptake of such a cessation aid would be poor (Ussher et al, 2001). This may also explain the negative results from certain studies that attempt to implement vigorous exercise interventions in a smoking population. In fact in such a sample this type of intervention may have significantly negative rather than positive effects. If exercise is to be used as a cessation aid in these groups then exercise of lower intensity and of shorter durations appear to be more appropriate. The question thus arises would this amount of exercise significantly reduce desire to smoke and withdrawal symptoms? Some research suggests it may (Ussher & West, 2004) although further investigations are needed in order to clarify these findings.
3.3.1 Willingness and motivations of smokers to do exercise

Doherty, Steptoe, Rink, Kendrick and Hilton (1998) in research investigating readiness to change health behaviours amongst patients at risk from cardiovascular disease found that patients who were contemplating, or preparing to stop, smoking were also more ready to increase their level of physical activity, more than those not considering giving up. This evidence points to the possibility that smokers who wish to stop may be more ready to adopt physical activity. However other research has found that exercise is generally not mentioned in smokers main strategies used for aiding cessation attempts (Katz & Singh, 1986). It may be the case that smokers just do not perceive exercise as a potentially useful tool in helping them to stop smoking.

Although the evidence presented does suggest that exercise may be useful as a smoking cessation aid if smokers do not actually want to do exercise then this is a pointless avenue of research. So far little research has investigated if smokers would be prepared to use exercise in this way, although what has been done is promising. For example Taylor (submitted), using internet discussion groups, reported the thoughts of exercise enthusiasts, (in this case runners and cyclists) about smoking. Specifically participants were asked how they felt exercise might decrease or increases their desire for a cigarette, and if exercise is useful in helping them reduce withdrawal symptoms. This was measured via ratings on likert scales, comments from participants were also examined using qualitative analysis to look for recurrent themes and issues. Findings indicated that the majority of respondents felt exercise decreased their desire to smoke, and again a majority indicated the positive effects of exercise on withdrawal symptoms. Qualitative analysis revealed several recurrent themes, including the role of exercise in elevating motivation to quit as an incompatible behaviour, weight management, taking on a new identity as a non smoker, and increased exercise to avoid withdrawal symptoms.

From these preliminary findings it certainly seems that smokers might be open to the use of exercise in smoking cessation. However it is important to recognise that the questions participants were asked were leading, with respondents well aware of the purpose of the study. This in itself may bring into question exactly how reliable these
findings actually are, only further investigation will confirm the results from this
study. Evidence from surveys suggests that other groups of smokers may be open to
the use of exercise. For example pregnant smokers have been found to be motivated
towards using exercise as an aid to smoking cessation (Ussher, Hibbs & West 2003).
Using exercise as a smoking cessation aid has the potential added advantage of
mitigating weight gain which some smokers report as being a matter for concern,
(Pomerleau Marks & Pomerleau, 2000; King Matachin, Marcus, Bock & Tripolone,
2000). Overall evidence in this area, although limited, suggests that smokers would
be willing to use exercise as a smoking cessation aid. A large scale investigation of
smokers views on this issue would be useful, and might provide sufficient evidence
to initiate further research into exercise and smoking.

3.4 CONCLUSIONS

In conclusion sufficient evidence in this area has been conducted that suggests
exercise reduces withdrawal symptoms and desire to smoke. However,
predominantly due to the methodological differences between different research
studies it is difficult to draw firm conclusions about this effect. A number of issues
need addressing before exercise can be implemented effectively as a smoking
cessation aid, specifically the durations and intensities that are required to exhibit
reductions in withdrawal, the mechanisms by which these reductions occur and how
best to integrate exercise in smoking cessation programmes. Due to the variety of
methodologies employed in this area a more consistent exploration of these issues
are required.

Current cessation methods, although effective, predominantly only moderately
increase the chances of cessation success compared to quitting with no cessation aids
at all. Also certain groups of smokers are unable or unwilling to use standard
cessation aids, such as pregnant smokers, and therefore more novel approaches to
cessation are potentially required for these groups. Overall the evidence in the area of
smoking and exercise merits further investigation. Specifically research using acute
exercise interventions should attempt to firstly, verify that exercise is effective at
reducing withdrawal, to investigate the limitations of the effect in terms of duration
and intensity of exercise, and to begin to explore possible mechanisms by which exercise may reduce withdrawal and desire to smoke. The following chapter will detail the first investigation of this thesis, investigating some of the issues presented above.
CHAPTER 4

STUDY 1

4.1 INTRODUCTION

As discussed in chapter 2, many of the commonly reported symptoms of smoking withdrawal are mood states reported to be effected by exercise. Acute bouts of exercise of moderate intensity and short duration appear to be effective in reducing depression and anxiety (Salmon, 2001). Research into smoking and exercise has predominantly failed to produce a comprehensive picture of what the benefits of exercise on smoking withdrawal correlates are. Some studies have reported positive effects whilst others have found no effect. The durations and intensities of exercise required to produce any reductions in these symptoms of abstinence are also unclear, as is exactly what mechanisms are involved in this relationship. This chapter will describe the first study of this thesis. Study 1 attempts to establish two things. Firstly whether short durations (five minutes) of moderate intensity exercise are effective at reducing withdrawal symptoms and desire to smoke. Previous research has established that 10 minutes of moderate intensity exercise is effective at significantly reducing withdrawal symptoms and desire to smoke (Ussher et al, 2001) however it is unclear what the effect of shorter durations will be. The second objective is to introduce a light intensity exercise condition in order to attempt to determine to what extent reductions in withdrawal may be due to exercise related distraction. In itself it will also be useful to determine if lower than moderate intensities of exercise are effective at reducing desire to smoke and common smoking withdrawal symptoms in abstinent smokers.

4.1.1 Exercise effects on smoking

Previous research investigating the effects of exercise interventions upon smoking withdrawal symptoms and desire to smoke have found, after short bouts of vigorous intensity exercise, a general decrease in desire to smoke (Pomerleau et al 1987).
Other researchers have also found some positive effects upon withdrawal symptoms due to exercise, for example desire for a cigarette being significantly reduced following exercise (Grove et al, 1993). Despite these positive findings the bulk of the research in this area has not had sufficient experimental rigour to make valid and reliable conclusions (Ussher et al, 2000).

Some research has addressed a number of these methodological problems (see Bock et al 1999; Ussher et al, 2001), and have subsequently provided valid evidence suggesting exercise can reduce common smoking withdrawal symptoms and desire to smoke. Ussher et al (2001) attempted to elucidate the effects of exercise on smoking withdrawal by conducting research in order to determine if moderate intensities of exercise, of short durations, were effective at reducing craving and desire to smoke in sedentary smokers. Results indicated that participants rating of withdrawal symptoms and desire to smoke were significantly lower in the middle of the exercise, at the end, and up to 15 minutes after exercise.

This research provides convincing experimental evidence that exercise of moderate intensities and of relatively short durations could potentially be effective at reducing smoking withdrawal symptoms in sedentary, acutely abstinent smokers. It remains a possibility that even shorter durations of moderate intensity exercise may be useful in reducing withdrawal and desire to smoke. As such the following investigation will implement shorter durations (5 minutes) of moderate intensity exercise in a sample of abstinent sedentary smokers, to determine effects on withdrawal and desire to smoke. Some evidence has suggested that intensities of exercise below moderate are sufficient to produce positive effects on withdrawal (Thayer et al, 1993). However this research only utilised a very small sample size and did not measure smoking specific withdrawal symptoms. This will be investigated further here also, by incorporating a light intensity exercise condition into the methodology.

4.1.2 Smokers activity level

A particularly important issue that the majority of exercise and smoking studies fail to address is related to the participants used within the research. Literature concerned
with the demographic representation of smokers within the UK suggests that the largest proportion of smokers tend to come from lower bands of socio-economic status (SES) (General Household Survey, 2002). It has also been found that it is these smokers who generally do very little or small amounts of exercise (Ford, Ahluwalia & Galuska, 2000). It may also be the case that due to limited economic resources these smokers are also less able to engage in regular exercise sessions. An important issue that presents itself is exactly what duration and intensity of exercise would be most beneficial to the majority of these smokers. It would seem to make sense that exercise of moderate intensity and of relatively short durations would be most beneficial to this group. An added problem of using exercise as a smoking cessation aid is it may also be difficult for smokers to stop smoking and at the same time start taking part in exercise, particularly if they had been sedentary previously. It may thus be easier for them to stop smoking and do light intensity exercise, rather than exercise of higher intensities. Adherence to this lighter intensity activity is theorized would be greater for this intensity of exercise (Ussher et al, 2001).

It is also important in terms of methodological rigour that all participants in research of this nature are of approximately the same activity level, as this may vary the effects of exercise on mood (Reed, Berg Latin & La Voie, 1998). This however has been neglected in most of this research area, it is therefore important that current level of fitness, and history of exercise, is taken into account when investigating exercise effects on mood. This has not been consistently done within the exercise and smoking literature either. This study will attempt to address this problem.

4.1.3 Perceived intensity of exercise

It is important to discern what intensity of exercise is required to exhibit positive effects on smoking withdrawal. Arguably, what is equally as important is how intense participants perceive exercise to be, regardless of what the actual intensity of exercise is. If subjective ratings of exercise intensity, and absolute intensity levels do not correspond then this may have important consequences for research in this area. Research for example suggests that current fitness levels appear to be related to how exercise intensity is perceived. Travlos and Marsi (1996) found that the fitter
participants were the more accurate ratings of perceived exertion (RPE) were. Marsh and Martin (1998) found that in terms of preferred cycling cadence fit participants, particularly experienced cyclists and runners, reported little change in rating of perceived exertion (RPE) despite changes in cycling speed. This research also reported that in physically active participants RPE were generally more accurate compared to sedentary individuals.

Another interesting possibility, specifically linked to smoking research, is that something integral to smoking exhibits some kind of effect on RPE. Nicotine for example might increase smokers RPE, and hence potentially make them less likely to take up exercise (it may well do this via the adverse effects smoking can have on health and fitness). However research findings have however failed to support this possibility. (Perkins, Sexton, Solberg-Kassel & Epstein, 1991). Variables that have been reported to effect RPE are for example, music (Potteiger, Schroeder & Goff, 2000) and certain other substances, such as glucose (Riddell, Bar-Or & Gergstein, 2000). Abadie (1996) found that viewing Borg’s rating of perceived exertion scale whilst exercising could also have an effect upon exertion rating. It may therefore be important to mask the actual rating scale when it is not in use.

Russell (1997) points out that no real concrete theory of perceived exertion exists. Research has suggested that some 30% of the variance between physiological factors and ratings of exertion remain unaccounted for (Williams & Eston, 1989). It is also unclear what psychological variables may be related to RPE either. Overall it appears that RPE is an important issue when investigating exercise. Failing to investigate perceived rating of exertion may miss vital information about preferred exercise intensity in participants. It may be that the use of exercise as a therapeutic tool for smokers may be effective if based on perception of exercise intensity, rather than intensity based on purely physiological factors. In Ussher et al’s (2001) investigation into moderate intensity exercise and smoking withdrawal it was found that participants persistently reported exercise to be harder than moderate intensity. Other research has suggested that exercising at a preferred intensity is as effective at reducing smoking withdrawal symptoms and desire to smoke (Katomeri, 2003) as exercising at set moderate intensity. Therefore RPE will be recorded in this study.
4.1.4 Relationship between distraction and exercise effects on withdrawal

Very little research in this area has suggested what mechanisms may be responsible for the effect exercise appears to have on withdrawal symptoms and desire to smoke. Some authors have suggested that a physiological mechanism may be responsible for this effect, such as realisation of catecholamines during exercise (Ussher et al., 2001). However there are also a number of alternative, non-physiological mechanisms that may be responsible for this effect, that as yet, have not been investigated. It seems sensible that before any in-depth investigation into possible physiological mechanisms take place that these alternative, higher order, psychological possibilities should be investigated first.

One of these possibilities is related to the distraction hypothesis of exercise and mood improvement. This theory maintains that it is not a specific action of exercise that enhances mood, but rather the fact it provides a respite or distraction from worry and stress (Raglin & Morgan, 1985). Some research has been conducted that has provided evidence that distraction is as effective as exercise at reducing negative mood. For example Bahrke and Morgan (1978) compared the effects of exercise, meditation and resting control on state anxiety. The authors found that all three groups exhibited equal reductions in state anxiety. It was suggested that this is evidence that suggests distraction alone is enough to produce positive effects on exercise and withdrawal. Other research has also found that relaxation or quite rest are as effective as exercise at reducing state anxiety (Brown, Morgan, & Raglin, 1993). However there are a number of alternative explanations for this finding. For example even though reductions in anxiety and other mood states in exercise conditions have not found to be significantly different from distraction conditions, this does not necessarily mean reductions in exercise groups were due to the same mechanism. It may well be the case that exercise reduces negative mood via other, possibly physiological mechanisms.

Other researchers have refuted these claims, by reporting evidence that suggests distraction is not sufficient to improve mood. For example Fillingham, Roth and Haley (1989) randomly assigned participants to exercise under three different
distraction conditions. Results indicated that low cognitive load distraction during exercise involved reductions in tension, whilst high demand cognitive distraction during exercise involved increases in tension. This is contrary to the distraction hypothesis, which would predict that high cognitive distraction would involve greater reductions in mood than less distracting conditions (although as high demand cognitive distraction may be stressful this finding is perhaps not so surprising).

Overall the distraction hypothesis seems a plausible alternative to biologically related mechanisms, and it is feasible that it may be responsible for the positive effects exercise has been found to have on smoking withdrawal symptoms and desire to smoke. In order to address this possibility within this study it is envisaged that a light intensity exercise intervention will provide the same distracting effect as higher intensities of exercise. In doing so it is predicted it will be possible to discern if distraction plays a part in reducing smoking withdrawal symptoms and desire to smoke.

4.1.5 Rationale for Study 1

The main aims of study 1 are to investigate the following: firstly to determine whether short durations of moderate intensity exercise (five minutes) are effective at reducing smoking withdrawal symptoms and desire to smoke. Withdrawal symptoms and desire to smoke will be measured before, during and after exercise using measures that have been used successfully in this area previously (Ussher et al, 2001; Ussher et al, 2003). In order to make the sample as representative of smokers as possible only self-reported sedentary smokers will be used in this study. A second exercise condition will also be introduced, this will consist of five minutes of light intensity exercise. The purpose of the introduction of this condition is two fold, firstly to determine if light intensity exercise in itself is effective at reducing symptoms and as a condition that will provide evidence that distraction is, or is not, responsible effective in reducing smoking withdrawal symptoms and desire to smoke.
4.1.6 Hypotheses

Specific hypotheses being tested in study 1 are listed below:

- There will be a significant reduction in smoking withdrawal symptoms and desire to smoke in sedentary smokers after acute smoking abstinence, during and following 5 minutes of moderate intensity exercise.

- There will be a significant difference between smoking withdrawal symptoms and desire to smoke in sedentary smokers after acute smoking abstinence, during and following 5 minutes of light intensity exercise.

4.2 METHOD

4.2.1 Participants

In total 118 participants were initially screened to take part in the experiment. Of these, 18 did not wish to take part after the initial screening procedure, and a further 16 did not make appointment dates for the testing procedure. In total 84 participants completed the testing procedure. The recruitment criteria were as follows, participants had to be between 16 and 65 years of age and not receiving any form of psychiatric treatment (a large proportion of smokers may have separate psychiatric problems which could influence the results (Black, Zimmerman & Coryell, 1999) hence the inclusion of this here). Participants also had to be smoking at least 10 or more cigarettes a day, for at least three years, and self report to be sedentary individuals. Being sedentary was defined as not engaging in vigorous exercise 3 or more times a week for at least 20 minutes each time or do moderate intensity activity at least five times a week for 30 minute periods or more (Franklin, 2000). Of this group of participants 41 were male and 43 were female. Their respective mean ages were 30.5 and 29.7 years old and all were classed as belonging to a white ethnic group. This selection criteria has also been utilised in other investigations into
exercise effects on smoking withdrawal. The University of Surrey's committee on ethics approved the study.

4.2.2 Materials

Participant's heart rates were monitored using a polar advantage heart rate monitor. This allowed for continuous heart rate monitoring at five-second intervals throughout the experiment. For the exercise conditions a Cateye ergociser C-3000© ergometer was used, seat height was adjustable as required and physical load was also adjustable. A carbon monoxide (CO) Bedfont Smokerlyzer© monitor was also used to monitor participant CO level prior to taking part in the experimental conditions. This was an attempt to ensure participants had remained abstinent from smoking for between 11-15 hours. Participants were also administered the Physical Activity Readiness Questionnaire (PAR-Q), a preliminary screening tool for exercise prescription and testing (Thomas, Reading & Shepard, 1992; see appendix 1). This was to ensure participants did not have any medical condition or illness that may have made taking part in exercise overly difficult or dangerous. As well as this screening procedure participants were told that if they were in the exercise condition, and at anytime during the exercise they felt uncomfortable they were to tell the experimenter immediately.

Psychological measures

The following are descriptions of all the psychological measures that were used.

**Fagerström test for nicotine dependence**, (Heatherton, Kozolowski, Frecker, & Fagerström, 1991; see appendix 2). This is a revised version of the Fagerström test for nicotine dependence (Fagerström, 1978), designed to provide a short convenient self-report measure of nicotine dependence. This measure purports to assess nicotine addiction via the following questions: number of cigarettes smoked per day, time of
first cigarette, difficulty smoking in non-smoking areas, frequency of smoking in the morning and continued smoking during illness. This revised version differs from the original in terms of scoring of time of first cigarette and number of cigarettes smoked questions. This questionnaire is used here as it has been found to be a valid and reliable measure of nicotine addiction and has been used extensively in the literature (Prokhorov, De Moor, Pallonen, Hudmon, Koehly et al, 2000; Radizus, Moolchan, Henningfield, Heishman, Gallo, 2001) and in smoking and exercise research in particular (Bock et al, 1999; Ussher et al, 2001). It is also simple to administer and takes a minimal amount of time to complete.

Seven-Day Physical Activity Recall Questionnaire (Sallis, 1978; see appendix 3). As it was essential that participants were sedentary the seven day physical activity recall questionnaire was used to determine the physical activity level of participants. Items on the instrument are designed to elicit information about type, duration and intensity of physical activity done over a seven-day period. Participants then compare this seven day period to the previous three months and estimate how typical this seven day period was of their past activity level. The questionnaire provides useful and reliable estimates of habitual physical activity (Blair, Haskell, Paffenberger, Vranizan, Farquhar, et al. 1985, Blair, 1984; Blair, Colingwood & Reynolds, 1984; Dubbert, Vander Weg, Kirchner, & Shaw, 2004).

Stages of change for physical activity (Marcus, Rossi, Selby, Niaura & Abrahams, 1992; see appendix 4). This requires participants to circle one of six statements concerning stages of readiness to adopt exercise behaviour. These were based on Prochaska, DiClementie and Norcross’ (1992) trans-theoretical model of behavioural change (stages of change model). After this questionnaire participants filled out two brief questions relating to how motivated they were to cease smoking at the time of the study and whether they intend to stop in the future. The first question was ‘do you want to stop smoking’, and ‘do you intend to make a serious attempt to stop smoking in the next three months’. Both questions were scored no = 0, maybe = 1 and yes = 2. These two latter questions were not based on previous research, and as such were merely exploratory questions.
**Borg Rating of Perceived Exertion Scale (RPE)** (Borg, 1998; see appendix 5). This scale reports to measure subjective feelings of exertion during exercise. Participants responded based on how hard they think they are working via their perception of strain on their muscles and discomfort in their chest during exercise. The RPE is administered using a scale from 6-20 (6 = no exertion, 20 = maximum exertion). The Borg scale of perceived exertion has been found to be a reliable and valid test of perceived exertion (Whaley, Woodall, Kaminsky & Emmet, 1997).

**Mood and Physical Symptoms Questionnaire (MPS)** (West & Russell, 1985; see appendix 6). This questionnaire measures mood and physical symptoms associated with common nicotine withdrawal symptoms and desire to smoke. The measure consists of eight questions that participants rate on a 7 point Likert scale (1 = not at all, 4 = somewhat, 7 = extremely). The questionnaire also incorporate a ‘Desire for a cigarette’ question from the Tiffany questionnaire, rated on a similar 7 point scale (1 = strongly disagree, 4 = neutral, 7 = strongly agree). This has been used in exercise and smoking research previously (Ussher et al, 2001; Ussher et al, 2003).

### 4.2.3 Procedure

All potentially interested participants were given an information sheet (see appendix 7). First participants had to undergo an initial screening procedure. This involved participants answering a number of health related questions, this was to ensure that participants did not have any medical condition that would have meant physical activity would have been aversive to them. Participant’s weight and height were also measured at this point. Participants were then told they were to abstain from smoking for at least 12 hours prior to testing. They were not to smoke again until the experimental procedure was over. All participants then had their CO measured 12-15 hours later. This was to verify they had not smoked for the previous 12-15 hours. This was done using a Bedfont Smokerlyzer®. A reading of 10ppm or less was used
to confirm abstinence for the given period. This has been found to be an effective way to estimate CO levels in the blood (Wald, Idle, Boreham & Bailey, 1981).

All participants were asked to sit down, and complete a written consent form as specifically stated in the terms and conditions of the ethical approval for the study. The following questionnaires were then administered to participants in all groups in the following administration order. First the Fagerström test for nicotine dependence, then participants completed the stages of change for exercise question and two brief questions about their desire and intention to stop smoking. Participants were then administered the seven day physical activity recall questionnaire followed by the mood and physical symptoms questionnaire and desire for a cigarette using the ‘desire for a cigarette’ item from the Tiffany scale. The scales were presented to participants via laminated cards. Administration of all the above instruments took approximately 15 minutes, all of which were administered whilst participants were sitting. Once administration was complete the heart rate of participants was measured, this was taken as average resting heart rate (RHR) via radial pulse measurement. Participants were then randomly allocated to either of the following conditions using a random number procedure (Statistical package for the Social Science, SPSS).

Exercise conditions

Those participants who were allocated to being in either of the two exercise conditions were then shown how to wear a chest band, which allowed continual heart rate monitoring via a wrist watch receiver. It was explained to participants that the wrist receiver would monitor their heart rate during the exercise condition, the experimenter would continually monitor this watch. If participants were not exercising within the required heart rate range, the experimenter would ask the participant to speed up or slow down accordingly, until sufficiently within heart rate limits. Participants could not see the heart rate monitor receiver during the exercise
as it was positioned away from them. Once this was done the exercise procedure started.

In the moderate intensity exercise condition participants were required to complete five minutes of moderate intensity exercise, formulated via the Karnovan method of heart rate reserve (HRR; Karnovan & Vuorimaa, 1988). This is a widely used method of calculating exercise intensity and is a recommended method prescribed by the American College of Sports Medicine (ACSM, 2000). Resting pulse was taken before participants were aware which condition they were allocated too. Moderate intensity exercise equated to between 40% and 60% of heart rate reserve (HRR 40% = 220 - age - resting heart rate / 0.4 + resting heart rate; Franklin, 2000). In the light intensity exercise condition participants were required to exercise between 10% and 20% of HRR. The following procedure was then the same for both exercise intensity conditions. Participants were not told which exercise intensity they would be exercising in, although once exercise began this became clear to them.

When participants were comfortable on the exercise bike it was explained that the experimenter would ask them a number of questions, during and after the exercise condition about how they were feeling at that particular moment in time. These questions consisted of the MPS as well as the RPE scale. Participants began a warm up period which lasted between 1 and 2.5 minutes, consisting of a gradual build up of heart rate until the participant was in their target heart rate zone. Once this continual heart rate range was achieved the condition was then timed.

Figure 4.1 is a diagrammatic representation of the timing of psychological measures. One minute into the exercise condition the RPE was administered. As with the MPS the RPE scale was presented to participants via a laminated card which was attached to the wall directly facing the participant, on the exercise bike. At 2.5 minutes the MPS was administered, again participants rated the same eight questions on scales presented to them. All scales were only visible to participants at the presentation periods, they were covered at all other times. At 4 minutes the RPE was administered.
again using the same presentation procedure and then at 5 minutes the MPS scale was administered again. At this point participants started to warm down, this lasted approximately two minutes, although they remained seated on the exercise bike until the third administration of the MPS was over.

Participants then dismounted from the bike, sat down and were asked to relax. They were told that the experimenter would not interact with them apart from to administer further measures. This was in order to keep distraction via social interaction to a minimum. The MPS was again administered at 10 minutes (5 minutes after the exercise condition), and then again at 15 minutes (10 minutes after the exercise condition). Participants were then informed that the test session was over, given a debriefing sheet (see appendix 8) and thanked for taking part.

Control condition

The control condition consisted of the same procedure as the previous two conditions with the exception that participants did not take part in any exercise, and they were not administered the RPE scale. Participants were required to sit quietly for 15 minutes, with social interaction between participant and experimenter kept to a minimum. Participants were again administered the MPS a total of five times, at baseline, 2.5 minutes, 5 minutes, 10 minutes and finally at 15 minutes. These are exactly the same timings as in the exercise conditions. Once the testing period was complete participants in the control condition were then debriefed in the same way as participants in the two exercise conditions.
4.3 RESULTS

Data are presented as means unless otherwise stated, standard deviations in parentheses (SD). For measurements taken repeatedly during all three trials a series of repeated measures analyses of variance (ANOVA) were performed. Planned comparison paired t-tests were conducted to determine if differences existed between baseline symptom ratings, and ratings at the proceeding four measurement periods (unless explicitly stated this type of analysis was used in all subsequent studies).

4.3.1 Sample baseline characteristics

Baseline characteristics of the three groups are shown in table 4.1. One-way ANOVA revealed no significant differences between the three groups on baseline characteristics. From this data it appears groups were not significantly different in terms of smoking and exercise behaviour.
Table 4.1: Mean (SD) values for participant characteristics

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Light</th>
<th>Moderate</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>31.0 (11.9)</td>
<td>29.5 (13.1)</td>
<td>29.8 (11.9)</td>
<td>ns</td>
</tr>
<tr>
<td>BMI</td>
<td>24.4 (3.1)</td>
<td>24.6 (3.5)</td>
<td>24.1 (3.4)</td>
<td>ns</td>
</tr>
<tr>
<td>Years Smoked</td>
<td>12.1 (7.5)</td>
<td>12.9 (1.3)</td>
<td>12.8 (5.8)</td>
<td>ns</td>
</tr>
<tr>
<td>Cigarettes per day</td>
<td>18.7 (8.3)</td>
<td>16.3 (6.3)</td>
<td>15.3 (5.3)</td>
<td>ns</td>
</tr>
<tr>
<td>FTND</td>
<td>4.6 (2.3)</td>
<td>3.8 (2.1)</td>
<td>3.6 (2.3)</td>
<td>ns</td>
</tr>
<tr>
<td>ECO</td>
<td>4.5 (2.9)</td>
<td>5.7 (2.9)</td>
<td>5.4 (2.9)</td>
<td>ns</td>
</tr>
<tr>
<td>Minutes moderate/vigorous intensity exercise per week</td>
<td>34.6 (13.2)</td>
<td>48.1 (9.4)</td>
<td>49.1 (8.1)</td>
<td>ns</td>
</tr>
<tr>
<td>Hours abstinence</td>
<td>13.2 (1.5)</td>
<td>13.4 (2.0)</td>
<td>13.3 (1.5)</td>
<td>ns</td>
</tr>
<tr>
<td>Motivation to quit</td>
<td>2.3 (1.39)</td>
<td>2.0 (1.26)</td>
<td>1.5 (1.3)</td>
<td>ns</td>
</tr>
</tbody>
</table>

(BMI = Body mass index; FND = Fagerström nicotine dependence questionnaire; ECO = expired carbon monoxide; ns = non significant)

Table 4.2 shows scores for stages of change for exercise. A chi-squared test revealed no significant differences between groups in terms of stage of change for exercise.

Table 4.2: Percentage scores for stages of change for exercise

<table>
<thead>
<tr>
<th>Stage of change</th>
<th>Control (n = 28)</th>
<th>Light (n = 28)</th>
<th>Moderate (n = 28)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-contemplation</td>
<td>14.3</td>
<td>17.9</td>
<td>14.3</td>
</tr>
<tr>
<td>Contemplation</td>
<td>14.3</td>
<td>21.4</td>
<td>28.6</td>
</tr>
<tr>
<td>Preparation</td>
<td>39.3</td>
<td>25</td>
<td>39.3</td>
</tr>
<tr>
<td>Action</td>
<td>10.7</td>
<td>28.6</td>
<td>7.1</td>
</tr>
<tr>
<td>Maintenance</td>
<td>21.4</td>
<td>7.1</td>
<td>10.7</td>
</tr>
</tbody>
</table>

4.3.2 Ratings of Perceived exertion

Table 4.3 shows mean ratings of perceived exertion and heart rate during exercise. Within the light exercise condition 100% of participants RPE were between 6 (no
exertion) to 11 (light) at one and four minutes into the exercise. Average rating of exertion at 1 minute in the light intensity group corresponded to very light on the Borg perceived exertion scale. In the moderate exercise condition at 1 minute 51.1% of participants rated exertion between 13 (Somewhat hard) to 15 (Hard, heavy). At 4 minutes 73% of participants rated exertion between 13 (Somewhat hard) to 17 (Extremely hard). Paired sample t-test revealed that RPE was significantly higher in the moderate group at 1 minute (t(28) = -12.009 p<.001) compared to 4 minutes (t(28) = -7.900 p<.001). Also heart rate at time 1 (t(28) = -15.834, p.001) and time 2 (t(28) = -15.451, p<.001) were significantly higher in the moderate intensity exercise group.

Table 4.3: Mean (SD) of ratings of perceived exertion and average heart rate during exercise

<table>
<thead>
<tr>
<th></th>
<th>Light (n = 28)</th>
<th>Moderate (n = 15)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPE 1 mins</td>
<td>8.7 (1.8)</td>
<td>13.3 (1.3)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>RPE 4 mins</td>
<td>9.0 (1.5)</td>
<td>13.4 (1.7)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>HR 1 mins</td>
<td>91.7 (9.8)</td>
<td>130.8 (8.2)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>HR 4 mins</td>
<td>91.1 (10.2)</td>
<td>133.9 (9.9)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

4.3.3 Withdrawal symptoms and desire to smoke

For ease of exposition results for the MPS items are presented together in table 4.4. Repeated measures ANOVA showed significant main effects of time were observed for desire for a cigarette, irritability, depression, tension, restlessness, difficulty concentrating, stress and strength of desire to smoke. There were significant main group effects for desire for a cigarette, depression and strength of desire to smoke. No significant main effect of group was found for irritability, tension, restlessness, difficulty concentrating and stress. Significant group by time main effects were found for desire for a cigarette, irritability tension, restlessness, difficulty concentrating, stress and strength of desire to smoke. A non-significant group by time interaction was found for depression. Mean ratings for each of the eight questions of the MPS and the desire to smoke Tiffany question are shown in Figure 4.2 (a-h).
Table 4.4: F values, degrees of freedom, and probability results for time, group and time by group interactions

<table>
<thead>
<tr>
<th>Time</th>
<th>Group</th>
<th>Time × group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time</td>
<td>Group</td>
</tr>
<tr>
<td></td>
<td>F value df P</td>
<td>F value df P</td>
</tr>
<tr>
<td></td>
<td>value</td>
<td>value df P</td>
</tr>
<tr>
<td>1. Desire for a cigarette</td>
<td>22.367 4 &lt;.001</td>
<td>4.066 2 &lt;.05</td>
</tr>
<tr>
<td>2. Irritability</td>
<td>6.426 4 &lt;.001</td>
<td>.078 2 =.925</td>
</tr>
<tr>
<td>3. Depression</td>
<td>2.4 4 &lt;.05 2</td>
<td>4.360 2 &lt;.05</td>
</tr>
<tr>
<td>4. Tension</td>
<td>11.213 4 &lt;.001</td>
<td>.735 2 =.483</td>
</tr>
<tr>
<td>5. Restlessness</td>
<td>8.495 4 &lt;.001</td>
<td>1.069 2 =.348</td>
</tr>
<tr>
<td>6. Difficulty</td>
<td>3.508 4 &lt;.05 2</td>
<td>.091 2 =.913</td>
</tr>
<tr>
<td>of concentrating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Stress</td>
<td>8.334 4 &lt;.001</td>
<td>2.265 2 =.110</td>
</tr>
<tr>
<td>8. Strength</td>
<td>24.775 4 &lt;.001</td>
<td>3.966 2 &lt;.05</td>
</tr>
<tr>
<td>of desire to smoke</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 4.2 (a-h): Ratings of withdrawal symptoms and desire to smoke at each measurement time (high=7, low=1). a Desire to smoke. b Irritability c Depression. d Tension. e Restlessness. f Difficulty concentrating. g Stress. h Strength of desire to smoke.

**Fig. 4.2 a)** Desire for a cigarette
Fig 4.2 b) Irritability

Fig 4.2 c) Depression

Fig 4.2 d) Tension
Fig 4.2 e) Restlessness

Fig 4.2 f) Difficulty concentrating

Fig 4.2 g) Stress
Paired sample comparison t-tests were calculated to compare measures of smoking withdrawal symptoms between baseline ratings and each respective time period (2.5, 5, 10 and 15 minutes) for the eight questions of the MPS in each condition (levels of statistical significance are presented in Table 4.5). Due to the high number of post-hoc t-tests carried out, 4 t-tests for each item of the MPS, a p<.001 significance level was adopted (Bonferroni t, 0.05/4 = .001). As Table 4.3 illustrates, in the control condition no significant differences were found between baseline ratings of withdrawal and at any subsequent time period.

For the light exercise condition desire for a cigarette ratings at 2.5 and 5 minutes were significantly different from baseline, as was tension at 2.5 and 5 minutes. Restlessness was significantly different at 2.5 and 5 minute time periods, and strength of desire to smoke was significantly different at 2.5 minutes. All other ratings were not significantly different from baseline at any other time period.

The majority of significant differences were observed within the moderate intensity condition. Desire for a cigarette and strength of desire to smoke were significantly different from baseline at 2.5, 5 and 10 minutes. Irritability, tension and stress were significantly different at 5, 10 and 15 minutes. Difficulty concentrating was significantly different from baseline at 10 and 15 minutes. Restlessness was found to be significantly different at all time points. Depression was not significantly different
at any time point over any condition. The remaining comparisons were non-
significant.

**Table 4.5:** The significance of comparisons of baseline ratings with each
subsequent measurement time for withdrawal symptoms and desire to smoke

<table>
<thead>
<tr>
<th></th>
<th>2.5 mins</th>
<th>5 mins</th>
<th>10 mins</th>
<th>15 mins</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Q1) Desire to smoke</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Light</td>
<td>***</td>
<td>***</td>
<td>**</td>
<td>ns</td>
</tr>
<tr>
<td>Moderate</td>
<td>***</td>
<td>***</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td><strong>Q2) Irritability</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Light</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Moderate</td>
<td>ns</td>
<td>ns</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td><strong>Q3) Depression</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Light</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Moderate</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td><strong>Q4) Tension</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Light</td>
<td>**</td>
<td>**</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Moderate</td>
<td>ns</td>
<td>**</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td><strong>Q5) Restlessness</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Light</td>
<td>**</td>
<td>**</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Moderate</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td><strong>Q6) Difficulty Concentrating</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Light</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Moderate</td>
<td>ns</td>
<td>ns</td>
<td>***</td>
<td>**</td>
</tr>
<tr>
<td><strong>Q7) Stress</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Light</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Moderate</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>**</td>
</tr>
<tr>
<td><strong>Q8) Strength of desire</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to smoke a cigarette</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Light</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Moderate</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
</tbody>
</table>

(*** = significantly different from baseline *p* < .001; ** = significantly different from baseline *p* < .01; ns = not significantly different from baseline)
4.3.4 Comparisons of reductions in symptoms

The analysis described in section 4.3.3 compared symptom scores for each group to their baseline readings. This assumes that because there are no significant differences between the groups at baseline it is acceptable to compare absolute scores between the groups at each time point. With this approach it has been suggested that it is still possible that a non-significant tendency for a difference between scores at baseline could affect the change score at each further time point. In order to assess this change scores were calculated i.e. ratings at 2.5 minutes minus baseline, ratings at 5 minutes minus baseline and so on. These change scores for each group were used in repeated measures ANOVA. When comparing this new analysis with the analysis of MPS items presented in section 4.3.3, significant main effects are identical (reported in appendix 9). As this was found to be the case it was felt further planned comparison t-tests would not be required, as results were the same as when the analysis was conducted using absolute scores.

4.3.5 Mediating factors in symptom reduction

Reduction of symptoms within the moderate intensity exercise condition were found to be significant over a longer period of time, particularly at 5 minutes post-exercise, compared to light intensity and control conditions. A number of correlations were conducted in order to determine if within the moderate intensity exercise group, any common factors existed within this group that were significantly related to reductions in symptoms. Taking the difference in ratings at baseline and at 5 minutes after exercise, significant correlations were observed for the desire for a cigarette item on motivation to quit scores (r=.446, p<.05) and number of cigarettes smoked (r=.476, p<.05). Also for the strength of desire to smoke item a significant correlation was observed with motivation to quit scores (r=.523, p<.05). This suggests there is a significant relationship between motivation to quit, and number of cigarettes smoked, and reduction in desire to smoke following exercise. Also motivation to quit smoking appears to be related to reductions in strength of desire to smoke 5 minutes post-exercise. This may have implications for which smokers will benefit most from using exercise as a cessation aid.
4.4 DISCUSSION

One aim of this research was to investigate whether a five-minute bout of moderate intensity exercise was effective at reducing withdrawal symptoms and desire to smoke, compared to five minutes of light intensity exercise and a resting control condition. The method also attempted to address whether distraction is responsible for reductions in withdrawal following exercise. Research has suggested that distraction, when compared to exercise, produce the same reductions in anxiety and other mood states after exercise (Morgan, 1997). This study attempted to investigate this possibility in a smoking and exercise context.

Significant reductions were observed in desire for a cigarette and strength of desire to smoke, irritability, tension, restlessness, stress and difficulty concentrating during and after exercise. It appears that after completing a short bout of moderate intensity exercise smoking withdrawal symptoms were significantly reduced. However by the end of the testing period (10 minutes after the exercise) symptoms had returned to baseline levels. Post-hoc comparisons showed no differences in the control condition, as expected. Within the light intensity condition some significant reductions in symptoms were observed although these symptoms returned to baseline quickly (relative to the moderate intensity condition). No reductions were observed 5 minutes post-exercise suggesting purely transient effects of light intensity exercise on withdrawal and desire to smoke. This evidence suggests that a five-minute bout of moderate intensity exercise is at least partly effective at reducing desire to smoke and other common withdrawal symptoms, in comparison with five minutes of light intensity exercise and a resting, control condition. Light intensity exercise appeared to have a transient effect on symptoms and desire to smoke. Hence exercise of at least moderate intensity appears to be required in order for reductions in withdrawal and desire to smoke to continue beyond the exercise itself, although these reductions only lasted five minutes beyond the exercise itself.

The results from this study suggest that light intensity exercise was sufficient to produce significant reductions in common withdrawal symptoms and desire to smoke during exercise, whereas moderate intensity exercise appeared to be effective during
and beyond 5 minutes of exercise. Other research has found that after longer durations of moderate intensity exercise, i.e. 10 minutes, ratings of desire to smoke and withdrawal symptoms were still significantly different from baseline (Ussher et al, 2001). It therefore may be the case that durations of 10 minutes of moderate rather than light intensity exercise will be more effective at reducing withdrawal than exercise of only 5 minutes duration, although this was not directly investigated here.

4.4.1 Distraction as a mechanism for symptom reduction

Studies looking specifically at the possibility that exercise related distraction is responsible for the positive relationship between exercise and mood have been conducted. Bahrke and Morgan (1978) investigating state anxiety reductions following exercise found similar reductions in a control and a meditation condition compared to exercise was effective at reducing negative mood. Raglin and Morgan (1986) found that vigorous physical activity reduced anxiety and that participants in distraction conditions reported significant decreases in negative mood. This has been reported elsewhere also (Bahrke, 1979). These results suggest that distraction alone may be effective at reducing negative mood, and that the mood improvements seen in exercise research are due to exercise related distraction rather than the exercise itself. A problem with this research is that researchers rarely actually explain what they refer to when they mean by exercise related distraction. It remains only a vague concept and as such it is difficult to compare effects of exercise related distraction with distraction from other sources. Although neither of these studies looked specifically at distraction and smoking withdrawal it remains a possibility that reductions in mood in abstinent smokers may also be due to distraction.

This study proposes that the distraction element of taking part in exercise is not sufficient to produce reductions in withdrawal and desire to smoke. The light exercise condition was intended to be comparable to the moderate intensity condition in every aspect, the only difference being the actual intensity of the exercise. It was attempted to keep the distraction elements of each condition the same as much as possible, however due to the fact that participants within the light intensity condition had to keep their heart rates in within a relatively narrow heart rate range, the
distraction element may have been even greater in this condition than the moderate condition, due to increased contact and communication from the experimenter (i.e. telling participants to slow down and speed up). Although at this stage it is unclear why exercise of moderate intensity causes reductions in smoking withdrawal symptoms, this study proposes that distraction is not the primary cause of this reducing effect. As transient reductions in withdrawal and desire to smoke were observed in the light intensity exercise condition distraction may have transient effects on these symptoms. Although this study does seem to suggest distraction is not responsible for exercises efficacious effect on withdrawal this was not a direct comparison between exercise and a pure distraction task. Further research needs to establish if non-exercise based distraction can reduce withdrawal in order to comprehensively rule out distraction as a potential mechanism for this effect.

4.4.2 Perceived intensity of exercise

Previous research in the field of exercise and smoking has suggested that acutely abstinent smokers, when completing moderate intensity exercise actually rate intensity of exercise as higher than moderate intensity (Ussher et al, 2001). It was found here that in the light exercise condition participants rated intensity of exercise accurately. In the moderate intensity condition however participants appeared to rate exercise intensity greater than moderate intensity. Average ratings of perceived exertion in this condition corresponded to hard and somewhat hard on the RPE scale (Borg, 1998). As the participants in this study were sedentary this finding is perhaps not so surprising, as previous research has found that less fit and less physically active participants are more likely to overestimate actual exercise intensity (Travlos & Marsi, 1996). There are other factors that might influence this relationship, for example there is some evidence to suggest that RPE is effected by things such as anxiety and depression (Morgan, 1994). This may have occurred here as smokers are withdrawing from smoking and are experiencing increased levels of such mood states. This may explain the overestimation of effort found in this study, although in the light intensity condition mood was as disturbed but no overestimation of effort was recorded. Some preliminary research has suggested that walking at a brisk pace for 5 minutes duration can have positive effects on mood, and increase positive affect
as well as reducing desire to smoke (Thayer et al, 1993). Research specifically investigating exercising at a preferred intensity and effects on smoking withdrawal have found positive results and this seems a fruitful avenue of future research (Katomeri et al, 2003).

4.4.3 Study limitations

One of the main limitations of this study was that amongst participants there appeared to be a large variation in what withdrawal symptoms participants reported, and the severity of them, i.e. some participants reported no difficulty concentrating over any measurement period whilst others reported very high symptoms. Research has found that not all smokers abstaining from tobacco use experience common withdrawal symptoms (Piascecki et al, 2000). As described in chapter I an atypical time course of withdrawal appears to occur in a large percentage of smokers attempting to quit. The second analysis of the data, using difference in scores rather than absolute scores was done to take this into account although similar results were found. This suggests this may not have been an important issue here.

Another potential limitation is concerned with the sample of participants used within this study. The sample used, when compared to samples used in previous research into smoking and exercise (i.e. Ussher et al, 2001) were on average 6 years younger, had been smoking for on average 12.5 years compared to 18.5 years in Ussher et al’s study and scores of nicotine dependence measures were lower. This may account for the variation in withdrawal symptoms observed in this study, as generally participants may not have been as addicted to smoking and therefore experienced less severe withdrawal symptoms during the abstinence period. Because of these factors the sample used in this study may be less representative of a population of smokers. However due to economic restrictions and time constricts it was not possible to recruit a wider, and perhaps more representative, sample hence a predominantly university based student population had to be utilised. This is not to say however that such a study is invalid, as results reported were inline with previous research. It therefore seems reasonable to use such a sample in this area of research.
Another potential confound to the study was that the MPS scale had to be administered twice in close time proximity. Due to the need for two administrations of the MPS in such a short time span (i.e. over 5 minutes) it may have been the case that participants sufficiently recalled their previous ratings hence influencing their subsequent judgements. This may also have become an irritation to participants due to having to answer the same questions in such close proximity, which in turn may have effected their mood ratings. Despite this possibility statistically significant effects were nevertheless still observed at these two measurement points. Another important point to note is due to the nature of exercise research participants have to warm up before they take part in exercise. In this study this consisted of gradual cycling until participants were within heart rate limits. It has to be noted therefore that participants would have exercised for more than 5 minutes. In fact duration of exercise was more likely to be between 5.5 and 6.5 minutes. As participants are required to warm up for a safe exercise session then it may not be possible to avoid this additional exercise.

As noted in section 4.3.5 of this chapter the analysis of the data set seemed to suggest that participants with certain characteristics might benefit more from exercise as a cessation aid, i.e. participants who had high motivation to quit exhibited larger drops in withdrawal symptoms and desire to smoke, relative to participants with lower motivation. It was found that, within the moderate exercise condition, there appeared to be a relationship between nicotine dependence level, motivation to quit and difference observed within desire to smoke question. Although these findings are far from conclusive they do point to the possibility that exercise and certain aspects of participants smoking behaviour may be significantly related.

4.5 CONCLUSION

The main aim of study 1 was to investigate the effectiveness of five minutes of moderate intensity exercise compared to five minutes of light intensity exercise at reducing common nicotine withdrawal symptoms and desire to smoke and passive
control. Results indicated that five minutes of light intensity exercise were not effective at significantly reducing symptoms beyond exercise, transient reductions in withdrawal for this intensity of exercise were observed. Five minutes of moderate intensity exercise was also effective at reducing desire to smoke and most withdrawal symptoms in the short term i.e. directly after five minutes of moderate intensity activity. Symptoms had however returned to baseline levels 10 minutes post exercise. It is not unequivocally possible to state from this research that moderate intensity exercise will be more effective at reducing withdrawal and desire to smoke than light intensity exercise, rather over a period of 15 minutes moderate intensity exercise appeared to reduce withdrawal for longer periods of time.

Also findings from this study suggest that distraction is not responsible for the phenomenon described here, hence it seems unlikely that reductions in symptoms are caused by exercise related distraction. Future research is required to explore the distraction hypothesis of mood improvement and exercise further, using a pure distraction condition to directly determine if distraction alone is effective at reducing smoking withdrawal symptoms and desire to smoke. Also as 5 minutes of exercise was found to be have limited durational effectiveness at reducing withdrawal longer durations need to be investigating to determine if longer durations lead to longer reductions in withdrawal and desire to smoke. Despite the wealth of evidence supporting increases in positive mood in general following exercise, this has yet to be investigated alongside withdrawal in exercising abstinent smokers. The following chapter will outline study 2, which attempts to address these issues.
5.1 INTRODUCTION

As study 1 demonstrated exercise related distraction does not appear to be effective at reducing smoking withdrawal symptoms and desire to smoke past exercise itself. The introduction of a light exercise condition within study 1 was envisaged to provide a way of assessing the effectiveness of exercise related distraction at reducing withdrawal. Although analysis of the data suggested that this condition was not effective at reducing withdrawal, this was not a direct comparison of distraction versus exercise. This condition still involved exercise so it was not possible to separate the effects of light intensity exercise, and the distraction caused by it, on smoking withdrawal symptoms and desire to smoke. A direct comparison of moderate intensity exercise and a pure distraction task would provide more conclusive validation of these previous findings. As study 1 found 5 minutes duration of moderate intensity exercise to be effective at reducing withdrawal for only 5 minutes post-exercise, 10 minutes duration will be investigated here in order to determine the effectiveness of longer durations of moderate intensity exercise. It also remains the case that the general mood effects of taking part in exercise might be responsible for changes in smoking related mood and desire to smoke during and after acute exercise. This study will also investigate this possibility.

5.1.1 Distraction within the exercise and smoking relationship.

Distraction is an important issue in attempting to understand mechanisms that may be involved in reductions in smoking related mood following exercise. From a methodological point of view however, it may prove difficult to conduct an experiment to investigate whether distraction is responsible for reductions in withdrawal. The difficulty arises from how one assesses distraction effectively without confounding study methodology, and also how to effectively replicate, and
manipulate distraction related to acute exercise. No research as yet has done this in a
smoking and exercise context, however some researchers have attempted to study
this issue investigating cognition during exercise and its effects on mood in general.
Bahrke and Morgan (1978) proposed a distraction hypothesis as a possible
explanation for how exercise might interact with mood. The distraction hypothesis
suggests that exercise might alleviate anxiety (Raglin & Morgan, 1985), and other
negative mood constructs via a process shared by quiescing treatments (i.e.
méditation).

Morgan (1994) suggests that engaging in activities such as running and meditation
creates a mental and physiological diversion from stressful thoughts and induces
lower levels of anxiety. Bahrke and Morgan (1978) stated that it is the diversional
aspects of these conditions that reduced anxiety. It may be the case that what an
exerciser thinks about when exercising may differentially effect how exercise
influences mood. This may explain the sometimes contradictory findings in exercise
and mood research. Pennebaker and Lightner (1980) examined the effect of different
attentional focus on exercising participants by playing distracting sounds or tapes of
participants own breathing whilst exercising. In a second study participants either
exercised outside (an outdoor cross-country course) or inside (on an indoor running
track). Results from both studies indicated that factors promoting attention to
external stimuli, in particular the external environment, reduced awareness of
internal sensations in the outside and sound conditions, exercise was assessed as
more enjoyable and less intense by participants.

Bourdeaudhuij, Crombez, Defourche, Vinaimont, Debode et al (2002) found that
participants who whilst exercising were listening to their favourite music, exercised
for longer compared to a group who had no distraction. The authors suggest that the
music focused participants attention externally, rather than internally, on bodily
discomfort. However, as music chosen was the participants’ own choice this may not
be so surprising an effect. Other authors have found that setting, attentional focus and
cognitive appraisal during exercise may alter the emotional experience associated
with physical exercise (Harte & Eifert, 1995). Other researchers have also
investigated distraction in this way (Breus & O’Connor, 1998; Fillingham & Fine,
1986; Johnson & Siegel, 1992; Hart & Eifert, 1995) and found similar results. Distraction strategies in other areas have also been found to be effective at changing mood and perception of discomfort, for example in decreasing the sensations of pain during dental procedures (Corah, Gale, Pace & Seyrek, 1981), electric shocks (Lavine, Buchsbaum & Poncy, 1976) and in pain management (Johnson & Petrie, 1997).

Boutcher and Trenske (1990) attempted to investigate the effect of distraction and deprivation on rating of perceived exertion (RPE) and affective responses during and after exercise. Twenty-four participants took part in three separate exercise sessions, which consisted of 6-min ergometer rides in which the workloads were set to produce heart rates at approximately 120, 150, and 170 beats per minute (these equate to moderate, hard and very hard exercise intensities). There were three experimental conditions, a deprived condition, this entailed participants wearing opaque goggles and ear plugs whilst exercising, a music condition consisted of participants listening through earphones to their favourite music and a control condition that consisted of participants exercising on the ergometer without sensory deprivation or musical distraction. Results indicated that RPE and affect were influenced by deprivation and music, with reductions in RPE being reported and increases in positive affect. This suggested that both RPE and affect can be influenced by music related distraction and sensory deprivation. Other authors have also found similar results, for example Gill and Strom (1985) found that female participants performing a repetitive leg-lifting task performed the activity better, and with more ease, when employing an external focus (dissociation) rather than an internal focus (association). It therefore appears to be the case that distraction when doing exercise can affect mood and perceptions of effort. As this occurs it seems feasible that reductions in withdrawal and desire to smoke may be affected in the same way.

Many of the conditions employed within the research above still contain exercise however so it is difficult to disentangle what is affected by exercise and what is affected by distraction separately. Also not all evidence has found support for distraction improving mood and affecting effort perception during exercise.
Fillingham, Roth and Haley (1989) investigated the effects of distraction on the perception of exercise induced symptoms. Participants were assigned to one of three conditions, high-demand distraction, low-demand distraction, or no systematic distraction. Participants were required to exercise on a stationary ergometer. In the high demand and low-demand conditions this involved participants completing a word task presented to them visually whilst they were exercising, the high demand condition requiring more attention as the task was harder. Measures of mood, perceived exertion during exercise, physical symptoms following exercise, and timed riding tolerance were collated before, during and after exercise. Fillingham et al found that distraction was not sufficient to reduce symptoms associated with exercise, and that mood was not affected differently when comparing participants across conditions.

Masters and Ogles (1998) concluded that little has been done to directly advance understanding of why, when and in what context distraction during exercise operates. In general, research in this area has shown that distraction is related to physiological awareness and ratings of perceived exertion in lab based studies, but no clear evidence is available regarding how this relates to exercise in other environments and how distraction may effect specific mood states. Also the way in which cognitive strategies are measured during exercise is problematic and can often invalidate research findings (Masters & Ogles, 1998). As an aim of this research is to investigate mechanisms by which exercise reduces smoking withdrawal related mood, and as research has established that distraction can affect perception of exercise sensations, it is essential that distraction is investigated in the context of smoking related mood and exercise. The issue remains, whether it is that smokers withdrawal is reduced during exercise because they are not focusing on internal feelings or is it a physiological effect of the exercise itself.

5.1.2 Exercise and acute changes in mood

Another possible explanation for the positive effects exercise has on smoking related mood is the potential that changes in affect due to exercise are directly related to reductions in smoking withdrawal and desire to smoke. A large amount of evidence
has pointed to the positive psychological implications of exercise, and as such general mood effects of exercise may be related to how exercise impacts on smoking withdrawal. However the relationship between smoking withdrawal, exercise and affect has not been investigated empirically. Research attempting to determine mechanisms responsible for the effect would benefit from exploration of mood alongside changes to smoking related mood. Watson and Clark (1992) argue that negative affect (NA) and positive affect (PA) account for a large amount of variance among emotion related terms. If positive and negative affect are measured alongside withdrawal symptoms it may be possible to ascertain if PA and NA are significantly related to smoking withdrawal reductions. As no research in the area of smoking and exercise has attempted to do this, it is felt that this is a vital investigation that will provide valuable information about the mechanisms that may be responsible for this phenomenon.

An issue of importance is how exactly to measure positive and negative affect. One of the most established and widely used measures of PA and NA is the Positive and Negative Affect Schedule (PANAS, Watson, Clark & Tellegen 1988). The PANAS has been used in a variety of settings (Vassed, 1994) and has been found to be a reliable and valid measure of PA and NA (Brown, Chorpita & Barlow, 1998; Crocker, 1997; Wilson & Gullone, 1999). The original PANAS scale may not be appropriate for the measurement of PA and NA in a short space of time due to number of items that make up the measure. The methodology that will be employed within this study entails repeated PANAS administration over a 30 minute period, so a short form of the PANAS would be more appropriate for use in this study. A short version of the scale has been found to be reliable and valid (Mackinnon, Jorm, Christensen, Korten, Jacomb et al 1999) and as such seems ideally suited to the measurement of mood within this study. An important point to note here is that questions on the PANAS and the MPS use similar items in terms of the moods they report to measure (distress and tension on the MPS and nervous and distressed on the PANAS for example). As such it is justifiable to predict certain significant relationships between such similar items because of shared variance.
Another mood related issue is feelings of enjoyment and discomfort in taking part in exercise. Researchers have provided some interesting findings into the effects of mood improvement following exercise and how enjoyment of exercise may be related to these improvements (Berger & Owen, 1986). Motl, Berger and Leuschen (2000) examined whether enjoyment of physical activity mediated the acute mood changes associated with exercise. Male participants took part in either a session of rock climbing or watching a health education video. Mood was assessed prior to the experimental conditions and following it. Rock climbers reported greater improvements in mood than those in the control condition. Results also indicated that scores on the enjoyment questionnaire had a direct relationship between changes in mood disturbance. Correlational analysis suggested that a combination of enjoyment and activity were related to acute changes in tension, depression and vigour. Motl et al therefore suggested that enjoyment appeared to mediate the acute mood changes associated with rock-climbing. This evidence suggests there is a significant relationship between enjoyment of exercise and mood changes due to exercise, however this study uses a fairly unusual form of exercise, i.e rock climbing, one that requires considerable skill and is a goal orientated exercise. This may have biased the results, and the conclusions therefore remain speculative.

Overall, enjoyment of exercise is worth investigating further within research into mood improvements in abstinent smokers, as this may be related to exercise induced improvements in symptoms of acute smoking withdrawal. Within this study enjoyment and discomfort associated with exercise will be measured in order to determine if enjoyment is related to changes in smoking related mood and desire to smoke following exercise.

5.1.3 Heart rate

Heart rate is another issue that is important when investigating smoking withdrawal as research has shown that smoking effects heart rate. Bernaards Twisk, Van Mechelen, Snel and Kemper (2003) employed a longitudinal design to look at the effects of smoking on fitness and heart rate response. Bernaards et al reported that there were reduced heart rate response to exercise in smokers. A negative
relationship between moderate and heavy smoking, and maximum heart rate after exercise was also found. This finding is particularly important if prescribing exercise of certain intensities to smokers as how they respond to certain exercise intensities, may be different to that of a non-smoking population, possibly due to these heart rate differences investigated above. Perkins, Epstein, Marks, Stiller and Jacob (1989) investigated chronic and acute nicotine tolerance and heart rate effects. After acute cessation (12-15hrs) a drop in heart rate of 8.5 beats per minute was reported, and resting heart rate was found not to return to baseline until on average 60 days after cessation. This fact has important implications for exercise prescription in smokers as the way intensity is calculated is usually based on resting heart rate. If exercise intensity is based on heart rate during abstinence it is questionable if this is an accurate representation of exercise intensity in smokers, as a smoker’s heart rate during cessation may not be an accurate picture of their ‘normal’, average heart rate, i.e. their average heart rate is arguably whilst they are smoking.

Studies looking into the area of exercise and smoking research rarely provide methodological details about how heart rate is measured, particularly in respect to exercise and cessation of nicotine use. This could potentially be a flaw with these research methodologies as the accurate testing of exercise intensities is crucial to the exercise and smoking paradigm. This is an issue that certainly merits further investigation. Study 1 of this thesis followed a similar approach to other smoking and exercise research and used resting heart rate after acute cessation to determine exercise intensities (Ussher et al, 2001). This study will record resting heart rate before cessation begins and then compare this with resting heart rate after acute cessation. By using heart rate before cessation to calculate exercise intensity it is felt this will be a more accurate way to test exercise of moderate intensity in this population.

5.1.4 Rationale for study 2

As the evidence presented above suggests, cognition during exercise is an important aspect of the exercise and mood relationship. The main aim of this study therefore is to investigate how attention, specifically distracted attention, influences smoking
withdrawal and desire to smoke. In this study 10 minutes of exercise will be compared to 10 minutes of a distraction task, a visual version of a serial addition task will be used within the distraction condition. The present study will also use existing measures to investigate a number of other issues related to smoking and exercise. These will include measuring positive and negative affect alongside smoking withdrawal and desire to smoke. As enjoyment and discomfort associated with exercise has also been found to be related to the psychological benefits of taking part in exercise this will also be measured.

5.1.5 Hypotheses

The specific hypotheses being tested within study 2 are listed below:

- There will be a significant reduction in smoking withdrawal symptoms and desire to smoke in sedentary smokers after acute smoking abstinence, during and following, 10 minutes of moderate intensity exercise.

- There will be a significant difference between the effects of 10 minutes of moderate intensity exercise and 10 minutes of a cognitive distraction task on acute smoking withdrawal symptoms and desire to smoke.

- There will be a significant relationship between ratings of negative and positive affect, and enjoyment and discomfort associated with exercise, and smoking withdrawal symptoms and desire to smoke.

- Resting heart rate will be significantly lower after 12-15 hours of smoking cessation compared to resting heart rate pre-cessation.
5.2 METHOD

5.2.1 Participants

In total 55 people were initially screened to take part in the experiment. Of these 9 did not wish to take part and a further 6 failed to make their appointment dates for the testing procedure. In total 40 participants completed the testing procedure. The recruitment criteria were the same as that described in chapter four (see section 4.2.1). Materials used for this stage of the experiment were also the same as those used in the previous study (see chapter 4, section 4.2.2 for details). The study was approved by the University of Surrey’s committee on ethics.

5.2.2 Psychological measures

The following are descriptions of all the psychological measures that were used. Measures already implemented within the previous study will only be noted, new measures used for the first time here will be described in more detail. For more detail for the measures already used refer back to chapter four for detailed description of these measures:

Measures that have been used in the previous studies included the Fagerström test for nicotine dependence (Heatherton et al, 1991; revised; see appendix 1). The Seven-Day Physical Activity Recall Questionnaire (Sallis, 1978; see appendix 2) and Stages of change for physical activity (Marcus et al, 1992; see appendix 4) were also collated. The Borg Scale of Perceived Exertion (Borg, 1998; see appendix 5) was used to measure ratings of perceived exertion during exercise. The following are descriptions of the psychological measures that were used for the first time here:

Mood and Physical Symptoms Questionnaire (MPS) (West & Russell, 1985; see appendix 10). This questionnaire measures mood and physical symptoms associated with common nicotine withdrawal symptoms and desire to smoke. This is the same
scale used in study 1, although in this study the measure was administered seven times over the experimental period.

**Positive and Negative Affect Schedule** (PANAS, Watson and Clark, 1992; see appendix 11). The PANAS is an instrument developed to measure positive and negative affect, using participant's self-ratings on 5 point scale on a number of emotion/feeling words. Participants rate how strongly they feel each mood state, either at that particular time (to measure state affect) or how much they have felt each mood state over the last 3 months (to measure trait affect). The version of the PANAS used here is a short form, utilising 10 items, 5 positive affect words and 5 negative affect words to measure state affect. This has been found to be a reliable short form of the PANAS (see Mackinnon, Jorm, Christensen, Korten, Jacomb et al, 1999).

**Enjoyment and discomfort questions** (see appendix 12). This consists of two brief questions to determine if participants enjoyed exercise and if they found it uncomfortable. The comfort question was ‘How much did you enjoy doing the exercise?’, participants responded on a 5 point scale (1 = not at all, 2 = a little, 3 somewhat, 4 = very much so, 5 = extremely so). The discomfort question was ‘How much discomfort did you feel during the exercise?’, participants responded on a 5 point scale (1 = just noticeable, 2 = very slightly, 3 = moderate, 4 = severe, 5 = very severe). These questions were devised from personal communication with Dr Michael Ussher (Ussher, 2002).

**Paced Visual Serial Addition Task** (PVSAT; Fos, Greve, South, Mathias & Benefield, 2000). This test is a visual version of the Paced Auditory Serial Addition Task (PASAT) (see Diehr, Heaton, Miller & Grant, 1998). The version of the PASAT used in this experiment consists of a practice session then two experimental sessions consisting of 4.5 minutes each. The task involves addition of small numbers (between 1-9), presented at 1 second intervals. Participants see a random number between 1 and 9 for 1 second, then a blank screen for 1 second, then another number between 1 – 9 for 1 second and this then repeats. The participant's task is to add the
two numbers together for the duration of the task. The task only requires participants to say the answer out loud. The PVSAT is a reliable task that requires focused attention and has been used in a number of clinical populations (Diamond, DeLuca, Kim & Kelley, 1997; Johnson, DeLuca, Diamond & Natelson, 1996).

5.2.3 Procedure

Firstly it was verbally explained to participants what the procedure involved and what was required of them. They were also given an information sheet (see appendix 13). Participants age, years smoked and number of cigarettes smoked per day were recorded, then participants were asked the 8 questions of the Physical Activity Readiness Questionnaire (PAR-Q; see appendix 1). This was to determine that participants were healthy enough to take part in 10 minutes of moderate intensity exercise. If participants had any contra-indications then they were told they could not take part in the experiment. At this point participants CO was measured to ensure that participants were smokers. A reading of 10ppm and above was considered sufficient evidence the participant was a current smoker. An appointment was then made for the actual testing session. Participants were informed they were to refrain from smoking from 11 pm the night prior to the test day, and that they were to remain abstinent until completing the procedure.

At testing participants’ CO was measured again, to ensure that participants had remained abstinent from smoking. A reading of 10 or below was considered an acceptable level of CO for a smoker who had been abstinent from smoking for between 11-15 hours. Participants then signed a written consent form and were made aware verbally that they would be able to withdraw from the experiment at any time if they wished. Participants then filled in the Fagerström test for nicotine dependence, then the seven-day physical activity recall questionnaire. After this participants filled in stages of change for physical activity and two brief questions on desire and intention to quit smoking cigarettes. At this point participants were fitted with a polar heart rate monitor (Polar advantage®) and were informed that their heart
rate would be continuously measured throughout the experimental period. The polar watch interface was not visible to participants during the experiment.

It was then explained to participants that during the experimental period they would be asked a number of questions regarding their desire to smoke and general mood (MPS) and that they would rate these questions on a scale from 1 to 7. These were displayed to participants via laminated A4 cards. The participants were also told that a further set of questions regarding how they felt would be presented to them at repeated times throughout the experiment (PANAS). Once participants were happy with proceeding and felt they sufficiently understood the questionnaires the experimental procedure began. Participants then completed the MPS and the PANAS, this was baseline recording. Timer and heart rate monitoring were then started. After 5 minutes of quiet resting participants completed the MPS and PANAS again, then again at 10 minutes (participants acted as their own controls), timer and heart rate monitoring were stopped as this was the end of the control condition period. Participants were then randomly allocated to either condition, using SPSS random number procedure.

Exercise condition

Participants were told they would now be completing 10 minutes of exercise on a stationary ergometer. Whilst participants seated themselves on the ergometer and made themselves comfortable the experimenter calculated participants heart rate limits (Karnoven method; Karnoven & Vuorimaa, 1988). Once this was done the participants were told that the experimenter would monitor the their heart rate during the exercise period, and that they were required to exercise in a moderate intensity range. This would be monitored via heart rate as displayed on the polar wrist interface by the experimenter. In order to keep possible distraction to a minimum participants were not able to see their heart rate via the polar watch interface at any time during the exercise condition. Participants were told they would again be asked to answer questions on the MPS and PANAS scales and also a rating of their perceived exertion (RPE) twice during the exercise. All scales were presented to
participants via laminated cards attached to the wall directly in front of the exercise bike (these were covered up and were only visible to participants when they were answering questions).

Participants then began a warm up period, which lasted approximately one to two minutes. Once participants were in their prescribed heart rate range the heart rate monitoring and timer were resumed. At 2.5 minutes into the exercise condition participants rated their perceived exertion, then at 4.5 minutes they rated mood via MPS and the PANAS. From 4.5 minutes into the exercise condition, until all questions were answered, participants stopped pedalling on the exercise bike (this enabled this condition to be comparable to the cognitive condition whilst participants were answering questions). It was found that despite ceasing exercising for approximately 1.5 minutes heart rates stayed sufficiently within target heart rate ranges. Once all questions were completed, which took approximately 1.5 minutes, participants resumed exercising. At 7.5 minutes they rated their perceived exertion again. Participants stopped exercising at 10 minutes, whilst they warmed down they rated the MPS and PANAS again. During the exercise condition participants answered the RPE, MPS and PANAS scales two times.

Participants then dismounted from the exercise bike, sat down and completed two brief questions (how much they enjoyed the exercise and how much discomfort they felt whilst doing the exercise). Once this was completed they sat quietly, and again communication between participant and experimenter was kept to a minimum. At 15 minutes (5 minutes post-exercise) participants completed the MPS and PANAS again. They then sat quietly for a further 5 minutes (10 minutes post-exercise), and completed MPS and the PANAS for the final time. At this point participants were given a debriefing sheet (appendix 14) and paid £10.00 for their participation.
Cognitive condition

After the initial 10 minutes of quiet resting participants were then told that they were going to complete a cognitive task on the computer (PVSAT). The instructions for the task were first explained to participants by the experimenter. They then completed a one minute practice of the task on the computer. Participants were then told that the task would consist of two 4.5 minute periods. Before, in between and after the task they would be asked a number of questions about how they were feeling (as they had done so previously). Heart rate was continuously measured throughout the test period as it was during the exercise condition. Before the first PVSAT period participants answered the PANAS and MPS questions. Then they completed 4.5 minutes of the PVSAT. Participants were told that their performance would be monitored via audio recording of their responses (this was done via tape recorder placed behind the participants, although in reality no recordings were actually made). Participants were asked to complete the task as well as they possibly could.

Once this period of testing was done participants then rated the PANAS and MPS questions. This lasted approximately 1.5 minutes. Once this was completed they went straight on to the second 4.5 minute period of the PVSAT. When this was finished the participants again rated MPS and PANAS questions. Participants were told that they would be required to sit quietly for a further 10 minutes, and that the experimenter would not communicate with them except to administer questions. At 5 minutes post-cognitive task the MPS and PANAS were measured again, and then again 10 minutes post the cognitive condition. At this point participants were given a debriefing sheet and paid the sum of £10.00 for their participation in the experiment.

Overall, in both conditions the MPS and PANAS were measured 7 times, at 0 minutes (baseline), then after 5 and 10 minutes of resting control. Experimental conditions then started, PANAS and MPS were measured at 15 and 20 minutes (5 minutes into the condition, then at 10 minutes), then both were measured at 25 and 30 minutes (5 and 10 minutes post-condition). Figure 5.1 illustrates the timing of psychological measure administration.
5.3 RESULTS

5.3.1 Sample baseline characteristics

Baseline characteristics of the two groups are presented in table 1. T-tests revealed no significant differences between the two groups on demographic variables, smoking dependence, number of cigarettes smoked, motivation to quit and expired carbon monoxide level at two separate readings.

CO measurement at time 1 and time 2 were compared using a paired sample t-test. A t-test indicated that CO measurements at time 1 (mean = 17, SD = 6.36) were significantly greater than CO measurement at time 2 (mean = 4.83, SD = 2.66), ($t(39) = 14.2$, $p<.001$) for participants in both conditions. This is as expected if participants had adhered to the 12-15 hours abstinence criteria. Table 5.2 shows scores for the
stages of change for exercise. A chi-squared test revealed no significant differences between the groups in stage of change for exercise.

**Table 5.1:** Mean (SD) values for participant characteristics.

<table>
<thead>
<tr>
<th></th>
<th>Cognitive</th>
<th>Moderate</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>23.1 (4.1)</td>
<td>23.7 (3.5)</td>
<td>ns</td>
</tr>
<tr>
<td>BMI</td>
<td>25.2 (3.3)</td>
<td>25.9 (4.8)</td>
<td>ns</td>
</tr>
<tr>
<td>Years Smoked</td>
<td>6.45 (4.5)</td>
<td>6.25 (4.8)</td>
<td>ns</td>
</tr>
<tr>
<td>Cigarettes per day</td>
<td>14.2 (5.3)</td>
<td>13.7 (5.3)</td>
<td>ns</td>
</tr>
<tr>
<td>FTND</td>
<td>3.4 (1.6)</td>
<td>2.7 (1.7)</td>
<td>ns</td>
</tr>
<tr>
<td>ECO – pre-abstinence</td>
<td>16.6 (6.1)</td>
<td>17.3 (6.7)</td>
<td>ns</td>
</tr>
<tr>
<td>ECO – during abstinence</td>
<td>4.5 (2.3)</td>
<td>5.1 (2.9)</td>
<td>ns</td>
</tr>
<tr>
<td>Resting heart rate – pre-abstinence</td>
<td>79.8 (18.1)</td>
<td>75.4 (12.3)</td>
<td>ns</td>
</tr>
<tr>
<td>Resting heart rate – during abstinence</td>
<td>74.6 (15.9)</td>
<td>71.9 (11.4)</td>
<td>ns</td>
</tr>
<tr>
<td>Hours abstinence</td>
<td>13.6 (2.1)</td>
<td>13.6 (1.3)</td>
<td>ns</td>
</tr>
<tr>
<td>Motivation to quit (0-6)</td>
<td>1.6 (1.1)</td>
<td>1.7 (1.3)</td>
<td>ns</td>
</tr>
</tbody>
</table>

(FND = Fagerström nicotine dependence questionnaire; ECO = expired carbon monoxide; ns = non significant)

**Table 5.2:** Percentage scores for stages of change for exercise (n)

<table>
<thead>
<tr>
<th>Stage of change</th>
<th>Cognitive (n = 20)</th>
<th>Moderate (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-contemplation</td>
<td>15.0 (3)</td>
<td>15.0 (3)</td>
</tr>
<tr>
<td>Contemplation</td>
<td>10.0 (2)</td>
<td>15.0 (3)</td>
</tr>
<tr>
<td>Preparation</td>
<td>20.0 (4)</td>
<td>30.0 (6)</td>
</tr>
<tr>
<td>Action</td>
<td>30.0 (6)</td>
<td>20.0 (4)</td>
</tr>
<tr>
<td>Maintenance</td>
<td>25.0 (5)</td>
<td>20.0 (4)</td>
</tr>
</tbody>
</table>
5.3.3 Ratings of perceived exertion and heart rate

Ratings of perceived exertion within the moderate intensity exercise condition were measured at 2.5 and 7.5 minutes into the exercise condition. Mean ratings at 2.5 minutes were 13.3 (2.5) and at 7.5 minutes 13.9 (2.1). This corresponds to 'somewhat hard' on the Borg scale. Paired sample t-tests indicated that there was no significant difference between perceived exertion at 2.5 minutes and 7.5 minutes (t(20) = -1.082, p = .293). Heart rate at 2.5 minutes into the moderate intensity exercise condition was 130.2 (9.7) and at 7.5 minutes into the exercise 134.5 (10.3) beats per minute. A paired samples t-test indicated heart rate at 2.5 minutes into exercise was significantly lower than heart rate at 7.5 minutes (t(20) = -2.790, p <0.05). Mean resting heart rate before cessation was 77.6 (15.4) and after 12-15 hours of smoking cessation was 73.3 (13.7). A paired samples t-test indicated heart rate during acute cessation was significantly lower than baseline resting heart rate pre-cessation (t(40) = -2.814, p <0.01).

5.3.4 Withdrawal symptoms and desire to smoke

For ease of exposition the results for the MPS items are presented together (see table 5.3). Repeated measures ANOVA showed that there were significant main effects of time interactions found for desire for a cigarette, irritability, depression, stress and strength of desire to smoke. No significant time interactions were found for tension, restlessness or difficulty concentrating. Significant main effects of group were found for desire for a cigarette, tension, restlessness, difficulty concentrating, stress and strength of desire to smoke. Depression and irritability were not found to be significant. Significant group by time interactions were found for desire for a cigarette, restlessness, depression, difficulty concentrating, stress and strength of desire to smoke. Tension was not found to have a significant group by time interaction. Mean ratings for each of the eight questions of the MPS and the Desire to smoke question of the Tiffany Scale are shown in Figures 5.2 (a-h).
Table 5.3: F values, degrees of freedom, and probability results for time, group, and time by group interactions

<table>
<thead>
<tr>
<th></th>
<th>Time</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F value</td>
<td>df</td>
<td>P value</td>
<td>F value</td>
<td>df</td>
<td>P value</td>
</tr>
<tr>
<td>Q1) Desire for a cigarette</td>
<td>6.297</td>
<td>3.49</td>
<td>&lt;.001</td>
<td>10.524</td>
<td>1</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Q2) Irritability</td>
<td>7.258</td>
<td>3.76</td>
<td>&lt;.001</td>
<td>3.190</td>
<td>1</td>
<td>ns</td>
</tr>
<tr>
<td>Q3) Depression</td>
<td>3.030</td>
<td>6</td>
<td>&lt;.05</td>
<td>2.580</td>
<td>1</td>
<td>ns</td>
</tr>
<tr>
<td>Q4) Tension</td>
<td>1.956</td>
<td>1.37</td>
<td>ns</td>
<td>5.238</td>
<td>1</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Q5) Restlessness</td>
<td>1.061</td>
<td>4.07</td>
<td>ns</td>
<td>4.358</td>
<td>1</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Q6) Difficulty</td>
<td>1.973</td>
<td>4.33</td>
<td>ns</td>
<td>5.154</td>
<td>1</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Q7) Stress</td>
<td>4.364</td>
<td>3.76</td>
<td>&lt;.05</td>
<td>5.890</td>
<td>1</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Q8) Strength of</td>
<td>3.042</td>
<td>3.66</td>
<td>&lt;.05</td>
<td>9.486</td>
<td>1</td>
<td>&lt;.05</td>
</tr>
</tbody>
</table>

(greenhouse epsilon = sphericity assumptions where necessary; df = degrees of freedom).

Fig. 5.2 (a-h): Ratings of withdrawal symptoms and desire to smoke at each measurement time (high=7, low=1). a) Desire to smoke. b) Irritability. c) Depression. d) Tension. e) Restlessness. f) Difficulty concentrating. g) Stress. h) Strength of desire to smoke.

Fig 4.2 a) Desire for a cigarette
Fig 5.2. b) Irritability

Fig 5.2. c) Depression

Fig 5.2. d) Tension
Fig 5.2. e) Restlessness

Fig 5.2. f) Difficulty concentrating

Fig 5.2. g) Stress
Eight paired sample comparison t-tests were calculated to compare measures of smoking withdrawal symptoms between baseline ratings and each respective time period (5, 10, 15, 20, 25 and 30 minutes) for both cognitive and moderate intensity exercise conditions. Due to the high number of post-hoc t-tests carried out (6 t-tests for each item of the MPS) a p<.008 significance level was adopted (Bonferroni t, 0.05/6 = .008). Table 5.4 illustrates these results.

For the cognitive condition the only significant differences from baseline were observed at 15 minutes for tension and at 15 minutes for difficulty concentrating, both of which increased compared to baseline ratings. For the moderate intensity exercise condition more significant effects were observed. Desire for a cigarette item ratings were significantly lower compared to baseline at 15, 20 and 25 minutes (this equates to the middle, at the end and 5 minutes after the exercise condition), irritability ratings were significantly lower than baseline ratings at 20, 25 and 30 minutes. Depression was only found to be significantly lower compared to baseline at 20 minutes. Tension was significantly lower at 20 and 30 minutes. Stress was significantly lower compared to baseline at 20, 25 and 30 minutes and strength of desire to smoke was significantly lower than baseline at 15, 20 and 25 minutes. No statistically significant differences were observed for restlessness and difficulty concentrating at any time point compared to baseline ratings.
Table 5.4: The significance of comparisons of baseline ratings with each subsequent measurement time for withdrawal symptoms and desire to smoke

<table>
<thead>
<tr>
<th></th>
<th>5 min Rest</th>
<th>10 min Rest</th>
<th>15 min Condition</th>
<th>20 min Condition</th>
<th>25 min Rest</th>
<th>30 min Rest</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Q1) Desire for a</strong></td>
<td>Cognitive</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td><strong>Q2 Irritability</strong></td>
<td>Cognitive</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td><strong>Q3) Depression</strong></td>
<td>Cognitive</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td><strong>Q4)Tension</strong></td>
<td>Cognitive</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td><strong>Q5) Restlessness</strong></td>
<td>Cognitive</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td><strong>Q6) Concentration</strong></td>
<td>Cognitive</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td><strong>Q7 Stress</strong></td>
<td>Cognitive</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td><strong>Q8) Strength of desire</strong></td>
<td>Cognitive</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

(*** = significantly different from baseline p< .001; ns = not significantly different from baseline.)

### 5.3.5 Comparison of reductions in symptoms

The analysis described in section 5.5.6 assesses symptoms in each group compared to their baseline readings. This assumes that because there are no significant differences between the groups at baseline it is acceptable to compare absolute scores between the groups at each time point. With this approach it is still possible that a non-significant tendency for a difference between scores at baseline could affect the change score at each further time point. In order to assess this change scores were calculated i.e. ratings at 5 minutes minus baseline, ratings at 10 minutes minus baseline and so on (as was done in study 1). These change scores for each group were used in repeated measures ANOVA’s. When comparing this new analysis with the analysis of MPS items presented in section 5.3.4 main effects are almost identical (reported in appendix 15).
5.3.6 Changes in Positive and Negative affect

Positive and negative affect were measured at the same time points as the MPS. Results from repeated measures ANOVA are presented in table 5.5. A significant main interaction of time, and group by time was found for PA, but no main effect of group was found. Similarly for NA a significant main effect of time, and group by time was found. No significant main effect of group was found for NA. Figure 5.3 a-b) illustrates mean scores on PA and NA.

Independent sample t-tests were performed to determine significant differences in ratings of PA and NA between the two groups. For PA no significant differences between the groups were seen. For NA significant differences were observed at 15 (p <.05), 20 (p<.05), 25 (p<.05) and 30 minutes (p< .05). In all these cases scores on NA were significantly greater in the cognitive condition compared to the exercise condition.

Table 5.5: F values, degrees of freedom and significant levels of the repeated measure ANOVA

<table>
<thead>
<tr>
<th>Time</th>
<th>F value</th>
<th>df</th>
<th>P value</th>
<th>F value</th>
<th>df</th>
<th>P value</th>
<th>F value</th>
<th>df</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive affect</td>
<td>5.796</td>
<td>6</td>
<td>&lt;.001</td>
<td>.237</td>
<td>1</td>
<td>.629</td>
<td>3.048</td>
<td>6</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Negative affect</td>
<td>6.213</td>
<td>6</td>
<td>&lt;.01</td>
<td>1.952</td>
<td>1</td>
<td>.170</td>
<td>12.223</td>
<td>6</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>
Table 5.6 and table 5.7 show correlations between positive affect and negative affect scores (measured by the PANAS) and items on the MPS across the 7 measurement periods. Positive and negative affect were found to be significantly correlated with items of the MPS. In the cognitive condition negative affect was significantly correlated with irritability scores at 5, 10, 15, 20 and 30 minutes, with depression at 5, 10, 15, 20, 25, and 30 minutes, with tension at 0, 10, 15, 20, 25 and 30 minutes, with restlessness at 5 and 20 minutes and stress at 5, 10, 15, 20 and 30 minutes. No significant correlations were observed for desire to smoke a cigarette, difficulty
concentrating and strength of desire to smoke. Positive affect was found to be significantly correlated with restlessness at 10 minutes, difficulty concentrating at 5, 10, 25 and 30 minutes and stress at 0 minutes. No significant correlations were observed for desire to smoke a cigarette, depression, tension and strength of desire to smoke.

For the moderate intensity condition negative affect was found to be significantly positively correlated with irritability at 5, 10, 15, 25 and 30 minutes, with depression at 5, 10, 15, 20 and 25 minutes, tension at 0 and 30 minutes, restlessness at 10 minutes, difficulty concentrating at 5, 10, 15, 25 and 30 minutes and stress at 10 and 25 minutes. Desire to smoke a cigarette and strength of desire to smoke were not significantly correlated with negative affect at any time point. Positive affect was found to be significantly correlated, in the moderate exercise condition, with irritability at 15, 20 minutes, tension at 5 minutes, difficulty concentrating at 5, 10, 15, and 20 minutes and stress at 5, 10 and 25 minutes. Desire for a cigarette and strength of desire to smoke was not significantly correlated with positive affect at any time point.

No significant correlations were found between positive affect and negative affect on the desire to smoke a cigarette item of the MPS or strength of desire to smoke question (Tiffany item) in either the exercise or the cognitive distraction condition. Changes in score on either of these two measures were not significantly related to changes across time on the desire for a cigarette and strength of desire to smoke questions. As no significant relationship with these items was found it was felt further analysis was not required.
### Table 5.6: Correlations between Negative Affect (NA) and MPS items

<table>
<thead>
<tr>
<th>Item</th>
<th>NA t1</th>
<th>NA t2</th>
<th>NA t3</th>
<th>NA t4</th>
<th>NA t5</th>
<th>NA t6</th>
<th>NA t7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1) Desire to smoke a cigarette</td>
<td>0.41</td>
<td>-0.10</td>
<td>0.17</td>
<td>0.16</td>
<td>0.20</td>
<td>0.04</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>0.11</td>
<td>0.11</td>
<td>0.11</td>
<td>0.11</td>
<td>0.11</td>
<td>0.11</td>
<td>0.11</td>
</tr>
<tr>
<td>Q2) Irritability</td>
<td>0.43</td>
<td>0.59</td>
<td>0.55</td>
<td>0.59</td>
<td>0.62</td>
<td>0.34</td>
<td>0.53</td>
</tr>
<tr>
<td></td>
<td>0.11</td>
<td>0.51</td>
<td>0.54</td>
<td>0.46</td>
<td>0.20</td>
<td>0.66</td>
<td>0.76</td>
</tr>
<tr>
<td>Q3) Depression</td>
<td>0.33</td>
<td>0.74</td>
<td>0.51</td>
<td>0.54</td>
<td>0.51</td>
<td>0.47</td>
<td>0.74</td>
</tr>
<tr>
<td></td>
<td>0.36</td>
<td>0.61</td>
<td>0.51</td>
<td>0.47</td>
<td>0.70</td>
<td>0.12</td>
<td></td>
</tr>
<tr>
<td>Q4) Tension</td>
<td>0.46</td>
<td>0.77</td>
<td>0.30</td>
<td>0.63</td>
<td>0.87</td>
<td>0.59</td>
<td>0.68</td>
</tr>
<tr>
<td></td>
<td>0.52</td>
<td>0.24</td>
<td>0.73</td>
<td>0.36</td>
<td>0.25</td>
<td>0.33</td>
<td>0.72</td>
</tr>
<tr>
<td>Q5) Restlessness</td>
<td>0.29</td>
<td>0.51</td>
<td>0.31</td>
<td>0.36</td>
<td>0.60</td>
<td>0.30</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>0.05</td>
<td>0.31</td>
<td>0.56</td>
<td>0.38</td>
<td>0.44</td>
<td>0.37</td>
<td></td>
</tr>
<tr>
<td>Q6) Difficulty</td>
<td>0.41</td>
<td>0.30</td>
<td>0.23</td>
<td>0.16</td>
<td>0.21</td>
<td>0.14</td>
<td>0.17</td>
</tr>
<tr>
<td>Concentrating</td>
<td>0.41</td>
<td>0.30</td>
<td>0.23</td>
<td>0.16</td>
<td>0.21</td>
<td>0.14</td>
<td>0.17</td>
</tr>
<tr>
<td>Q7) Stress</td>
<td>0.38</td>
<td>0.66</td>
<td>0.68</td>
<td>0.54</td>
<td>0.55</td>
<td>0.29</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>0.34</td>
<td>0.29</td>
<td>0.51</td>
<td>0.16</td>
<td>0.21</td>
<td>0.30</td>
<td>0.29</td>
</tr>
<tr>
<td>Q8) Strength of Desire to smoke a cigarette</td>
<td>-0.02</td>
<td>0.15</td>
<td>0.10</td>
<td>0.05</td>
<td>0.19</td>
<td>0.03</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>-0.21</td>
<td>0.23</td>
<td>0.15</td>
<td>0.01</td>
<td>0.16</td>
<td>0.03</td>
<td>0.12</td>
</tr>
</tbody>
</table>

### Table 5.7: Correlations between Positive Affect (PA) and MPS items

<table>
<thead>
<tr>
<th>Item</th>
<th>PA t1</th>
<th>PA t2</th>
<th>PA t3</th>
<th>PA t4</th>
<th>PA t5</th>
<th>PA t6</th>
<th>PA t7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1) Desire to smoke a cigarette</td>
<td>0.33</td>
<td>0.29</td>
<td>0.02</td>
<td>0.07</td>
<td>-0.26</td>
<td>-0.06</td>
<td>-0.15</td>
</tr>
<tr>
<td></td>
<td>0.25</td>
<td>0.03</td>
<td>-0.03</td>
<td>-0.05</td>
<td>-0.28</td>
<td>-0.15</td>
<td>-0.05</td>
</tr>
<tr>
<td>Q2) Irritability</td>
<td>-0.09</td>
<td>-0.28</td>
<td>-0.37</td>
<td>0.00</td>
<td>-0.25</td>
<td>-0.09</td>
<td>-0.19</td>
</tr>
<tr>
<td></td>
<td>0.18</td>
<td>0.23</td>
<td>0.49</td>
<td>0.49</td>
<td>0.30</td>
<td>0.16</td>
<td>0.03</td>
</tr>
<tr>
<td>Q3) Depression</td>
<td>-0.15</td>
<td>0.10</td>
<td>-0.42</td>
<td>0.04</td>
<td>-0.19</td>
<td>0.05</td>
<td>-0.21</td>
</tr>
<tr>
<td></td>
<td>0.30</td>
<td>0.34</td>
<td>0.23</td>
<td>0.18</td>
<td>0.02</td>
<td>0.03</td>
<td>0.09</td>
</tr>
<tr>
<td>Q4) Tension</td>
<td>0.25</td>
<td>0.18</td>
<td>0.23</td>
<td>0.21</td>
<td>0.17</td>
<td>0.01</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>0.60</td>
<td>0.22</td>
<td>0.34</td>
<td>0.29</td>
<td>0.29</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>Q5) Restlessness</td>
<td>-0.18</td>
<td>-0.20</td>
<td>-0.51</td>
<td>-0.27</td>
<td>-0.11</td>
<td>-0.18</td>
<td>-0.25</td>
</tr>
<tr>
<td></td>
<td>-0.07</td>
<td>0.12</td>
<td>0.30</td>
<td>0.29</td>
<td>0.36</td>
<td>0.52</td>
<td>0.42</td>
</tr>
<tr>
<td>Q6) Difficulty</td>
<td>-0.19</td>
<td>-0.57</td>
<td>-0.60</td>
<td>-0.19</td>
<td>-0.43</td>
<td>-0.58</td>
<td>-0.50</td>
</tr>
<tr>
<td>Concentrating</td>
<td>0.49</td>
<td>0.61</td>
<td>0.47</td>
<td>0.54</td>
<td>0.46</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>Q7) Stress</td>
<td>-0.56</td>
<td>-1.03</td>
<td>-0.42</td>
<td>0.01</td>
<td>-0.20</td>
<td>0.05</td>
<td>-0.12</td>
</tr>
<tr>
<td></td>
<td>0.64</td>
<td>0.59</td>
<td>0.41</td>
<td>0.33</td>
<td>0.27</td>
<td>0.45</td>
<td>0.26</td>
</tr>
<tr>
<td>Q8) Strength of Desire to smoke a cigarette</td>
<td>0.06</td>
<td>0.12</td>
<td>0.02</td>
<td>0.04</td>
<td>-0.26</td>
<td>-0.21</td>
<td>-0.18</td>
</tr>
<tr>
<td></td>
<td>-0.07</td>
<td>0.05</td>
<td>0.19</td>
<td>0.08</td>
<td>-0.29</td>
<td>-0.13</td>
<td>0.03</td>
</tr>
</tbody>
</table>
5.3.7 Mediating factors in symptom reduction

Differences between baseline ratings of desire to smoke and ratings directly after the exercise condition were statistically analysed in the exercise group, with the aim of investigating if sub groups within the exercise condition reported larger drops in withdrawal and desire to smoke after exercise. Correlations were conducted between change scores and motivation to quit scores, average number of cigarettes smoked per day, enjoyment and discomfort associated with exercise, amount of moderate and vigorous exercise and scores on the Fagerström nicotine dependence questionnaire. None of these were found to be significantly related. Smokers who were more motivated to quit and smoked more have been found to have larger reductions in withdrawal symptoms and desire to smoke (see study 1, section 4.3.5, chap 4). These findings were not supported here. Participant ratings of enjoyment and discomfort of exercise were also examined in relation to effectiveness of exercise at reducing withdrawal and desire to smoke. Correlational analysis was conducted investigating the relationship between these variables and scores on the MPS. No significant relationships were found suggesting discomfort and enjoyment associated with exercise are not significantly related to changes in withdrawal symptoms and desire to smoke.

5.4 DISCUSSION

The findings of this study support the findings of study 1 (see chp 4), in the sense that moderate intensity exercise was shown to reduce common withdrawal symptoms and desire to smoke during, and immediately after, exercise. These reductions are also consistent with previous research (Ussher et al, 2001) which also investigated 10 minutes of moderate intensity exercise. During and immediately after exercise common withdrawal symptoms and desire to smoke were rated significantly lower than rating at baseline. Planned comparisons indicated that these reductions returned to baseline by 10 minutes post exercise, specifically strength of desire to smoke and desire for a cigarette. The results corroborate with current research concerning exercise and smoking i.e. that moderate intensity exercise of a relatively short duration produces significant acute reductions in withdrawal symptoms and desire to smoke.
smoke however, unlike previous research (Ussher et al, 2001) these did not last for longer than 10 minutes.

5.4.1 Distraction

The methodology of study 1 utilised two exercise intensity conditions in order to investigate if performing exercise of light or moderate intensity, caused reductions in withdrawal and desire to smoke. Reductions were observed during the exercise in both conditions but once exercise stopped reductions were no longer seen in the light intensity condition. This experiment supports these previous findings, suggesting distraction alone is not responsible for observed reductions in desire to smoke and smoking related negative mood.

A cognitive distraction task was used in this study in order to assess whether distraction alone was sufficient to produce beneficial effects on withdrawal symptoms. The task was specifically chosen as it did not allow participants to use any mental resources (and possibly central executive functions) to monitor how they felt (Diehr et al, 1998). It is possible to argue that the cognitive condition used within this experiment was not sufficiently similar to distraction experienced during exercise to make conclusions about exercise and distraction in general. This may be the case, however to truly explore the distraction hypothesis research is needed that investigates distraction without accompanying exercise. Evidence so far is unclear what exactly constitutes distraction during exercise (Masters & Ogles, 1998), specifically smoking and exercise research has failed to address this issue. The aim of investigating distraction at all is to establish a potential mechanism by which exercise reduces withdrawal symptoms and desire to smoke. By utilising a pure distraction condition within this experiment it appears that pure cognitive distraction is insufficient in causing these reductions. In must also be noted however that the cognitive task used in this study was quite a ‘boring’ task and participants found the task tiring. Future research should consider using more interesting tasks to determine if they would be effective at reducing withdrawal and desire to smoke.
5.4.2 Exercise related affect

In terms of mechanisms responsible for withdrawal reductions, one possibility is that changes in affect and mood due to exercise are responsible, or at least related, to reductions in smoking withdrawal symptoms. Exercise enhances mood (as has been seen in much previous research; see Bryne & Bryne, 1993; Yeung, 1996 for reviews of this literature) and this enhancement may be causally related to reductions in withdrawal symptoms and desire to smoke. In order to attempt to investigate this within this research, positive and negative affect was measured at baseline, then at the same time periods as withdrawal symptoms and desire to smoke. Statistical analysis revealed there were significant main effects of time and time by group for PA and NA. This finding is consistent with previous research that has suggested exercise produces changes in affect. In the cognitive condition negative affect was significantly elevated compared to the exercise condition during and after the cognitive task. This is perhaps not surprising considering the mental and attentional demands the task placed on participants.

In terms of PA, NA, and withdrawal symptoms correlational data suggested a pattern that would have been expected if positive and negative affect were not related to withdrawal and desire to smoke. Specifically, significant correlations between ratings for affect and withdrawal were observed for some of the withdrawal items but not for desire for a cigarette and strength of desire to smoke (these being the most consistent and arguably most important feature of smoking withdrawal).

Significant correlations were observed in both conditions between negative affect and some of the items of the MPS, perhaps not surprisingly as many of the items in the PANAS were measuring similar concepts to items on the MPS. For example in the PANAS scale measurements were made using stress, distress, upset and scared items compared to ratings of tension, stress and depression in the MPS. It was expected that negative affect would be related to scores for withdrawal as these are predominantly negative moods and feelings, and are essentially the same mood concepts. Few significant correlations were observed with positive affect scores, perhaps as no items on the MPS were concerned with positive mood. Therefore
evidence presented here suggests there is no significant relationship between negative and positive affect and desire to smoke following acute cigarette abstinence.

The interpretation of these findings are important, as they point to the potential relationship between common mood effects of exercise, in connection with smoking withdrawal symptoms and desire to smoke. The results appear to suggest that when a smoker who is withdrawing from smoking completes 10 minutes of moderate intensity exercise desire to smoke and strength of desire for a cigarette are unrelated to changes in positive and negative affect. There does appear to be some association between negative affect and specific withdrawal symptoms although this only appears to be the case for certain symptoms, at certain points in the experimental procedure. Positive affect on the other hand appears to be predominantly unrelated to withdrawal symptoms and desire to smoke. In conclusion there does not appear to be any significant association between affect and desire to smoke.

5.4.3 Heart rate

Results indicated that resting heart rate prior to smoking abstinence was significantly higher than resting heart rate during cessation, which indicates a significant drop in heart rate after 12-15 hours of smoking cessation. As this was found to be the case, supporting previous research (West & Schnieder, 1988), exercise intensity calculations were based on resting heart rate before the cessation period. It was felt that in doing so this would be a more realistic intensity for smokers to exercise at. Significant reductions were still observed using this intensity calculation and as such this research suggests that this may be the most realistic way to test, sedentary acutely abstinent smokers, at specified intensities of exercise.

5.5 CONCLUSIONS

This study provides a number of conclusions about certain variables that are involved in the relationships between acute smoking withdrawal symptoms, desire to smoke and exercise. Specifically, 10 minutes of moderate intensity exercise appears to be effective at reducing withdrawal symptoms commonly associated with acute nicotine
withdrawal and desire to smoke following acute abstinence (between 12 -15 hours). Cognitive distraction is not an effective strategy for reducing withdrawal symptoms, and as such this provides evidence that it is unlikely that reductions in withdrawal during and following exercise are due to distraction. General mood effects of moderate intensity exercise also were not found to be associated with reductions in desire to smoke. This suggests that changes in mood, specifically exercise related changes in positive and negative affect, are unlikely to be responsible for reductions in certain withdrawal symptoms and desire to smoke during and following exercise. Ratings of perceived exertion were found to be high in the exercise condition, with participants generally reporting exercise to be of harder than moderate intensity, this was also found to be the case in study 1. This suggests that sedentary smokers are inaccurate at rating intensity of exercise, which may reflect their lack of exercise participation, and their general sedentary behaviour.

Results also suggested that 10 minutes of moderate intensity exercise is effective at significantly reducing withdrawal regardless of age, number of cigarettes smoked per day, self-reported dependence on smoking and motivation to quit. In study 1 dependence was found to be related to effectiveness of exercise at reducing withdrawal, which may indicate that certain smokers will benefit more from using exercise as a smoking cessation aid compared to others. This study however does not support this finding and as such further research needs to investigate this in more detail. Overall this investigation provides further empirical evidence for the potential usefulness of acute bouts of moderate intensity exercise at reducing withdrawal symptoms and desire to smoke, and also points to two different areas (exercise related affect and distraction) that do not appear to be related to the mechanisms by which this effect occurs.
6.1 INTRODUCTION

Study one provided evidence to suggest that some smokers may benefit more from the use of exercise as a smoking cessation aid compared to others i.e. those who smoked more and were more motivated to quit experienced greater reductions in withdrawal following exercise. The following study will examine a number of variables in order to determine if they are related to reductions in withdrawal following exercise. The aim of this is to establish if a sub-group of smokers may benefit more from using exercise as a smoking cessation aid compared to others. Expectation of the psychological effects of exercise on mood will also be investigated in order to determine how this might effect the relationship between exercise and smoking withdrawal. This investigation comprises two parts, study 3a and study 3b, and as such will be reported in two separate chapters (Chp 6 and Chp 7). The first part of the experiment utilises a questionnaire to gather information concerning motivation to smoke. Self-reported cessation history and history of physical activity will also be recorded in order to attempt to determine if any relationship between these variables exists.

6.1.1 Smoking motivation

The main aim of Study three is to investigate and record motivational variables amongst smokers, with the aim of using this information in the second stage of this study. As dependence on smoking, and number of cigarettes smoked were found to be related to exercise related reductions in withdrawal symptoms in study one, it is predicted that a dependence related motivation to smoke may also have the same relationship with reductions in withdrawal. Hence if this is found to be a motivational factor in the following analysis it will be used to distinguish smokers in the exercise intervention stage of this study. One of the issues that arises here is how best to measure motivation to smoke and what instruments to use to do this. There are a number of measures that purport to measure motivation to smoke, and it is a
source of some debate which is the most appropriate to use in smoking research. For example Carton, Houezec, Lagrue and Jouvent (2000) measured motivation to smoke alongside other factors such as introversion and extroversion. In Carton et al's study the classification of smoking by motives questionnaire (CSM; Russell, Peto & Patel, 1974) was used to measure motivation. The CSM reports to identify 'types' of smoking via factors that motivate people to smoke. These were interpreted as stimulant, indulgent, psychosocial, sensorimotor, addictive, automatic and sedative motivations to smoke. Carton et al concluded that using other measures (such as sensation seeking and extroversion scales) may be just as useful in determining motivation to smoke than specific motivation to smoke measures. Other researchers however do not believe this is to be the case.

Joseph, Manafi, Iakovaki and Cooper (2003) reported two studies investigating the association between personality and smoking motivation. Results of the first study indicated that smoking motivation was associated with self-efficacy to quit, with low self-efficacy related to automatic habitual smoking, negative affect control, and social skills deficits. Study two suggested that depression was specifically associated with smoking for negative affect control, whereas experience related to psychosis (schizotypy) were found to be associated with smoking for sensory stimulation. Joseph et al point out that many studies have established that differences in personality do exist between smokers and non-smokers. For example some studies have reported differences on Eysencks' personality dimensions between smokers and non-smokers, and smokers have been found to score higher on extraversion (Cherry & Kiernan, 1976; Helgason, Fredrikson, Dyba & Steineck, 1995) and neroticism (Canals, Blade & Domenech, 1997). There may however be an issue of stability of these personality factors that may cast some doubt on these findings.

In Joseph et al's study the Spielberger (1982, 1986) smoking motivation questionnaire was used to measure motivation to smoke. This is a 36-item measure that is grouped into five factors. These are interpreted as negative affect control (smoking when feeling irritated), restful and relaxing (smoking when feeling relaxed), intellectual stimulation and curiosity (smoking when feeling inquisitive),
automatic and habitual (smoking but not remembering lighting up) and social attractiveness and sensory stimulation (smoking to look mature and sophisticated). Papakyriaizi and Joseph (1998) investigated personality factors and how these related to scores on this questionnaire and its factor structure as well as the self-administered dependence scale (Davis, Hunt, Offord, Lauger, Morse et al, 1994). The authors found that personality was associated with both smoking motivation and nicotine dependency. More introverted smokers appeared to attempt to use smoking to try and enhance their social skills and neurotic smokers appeared to use cigarettes as a way of controlling negative affect.

From the research described so far it seems plausible that smokers may have a number of different motivational characteristics. West et al (1999) when investigating the possibility of using glucose tablets as an aid to smoking cessation also measured smoking motivation with an aim to investigate the possibility that different motivations to smoke might be related to strength and onset of abstinence symptoms. A new smoking motivation measure designed for use within this study was used, the aim of the questionnaire being to assess how far specific self-reported motives to smoke related to features of smoking abstinence. The questionnaire consisted of 7 questions that participants rated on how far they smoke, to keep weight down, cope with stress and socialise, as well as other items. West et al found that self-reported smoking to reduce discomfort significantly correlated with urges to smoke during abstinence. Also smoking to keep weight down was associated with urge to smoke. This evidence suggests that motivation is associated with smoking withdrawal and desire to smoke, and as such should be an important consideration when devising new smoking cessation techniques. It may be the case that certain smokers will benefit more from certain cessation techniques compared to others.

Russell, Peto and Patel (1974) conducted a factor analysis (FA) on two previous smoking typology sub-scales (Horn-Tompkins typology, Tompkins, 1966; McKennell-Thomas Typology; McKennell, 1970) in an attempt to determine a comprehensive measure of smoking motivation. Russell et al describe six factors that emerged from the initial FA. These were interpreted as psychosocial, indulgent, sensiromotor, stimulation, addictive and automatic motivations to smoke. Russell et
al emphasised that the six factors represent types of smoking and not types of smoker, although the authors note that it is reasonable to assume that there is some association between a smoker and his/her predominant pattern of smoking. Also Russell et al notes that a smoker is unlikely to score predominantly on one factor, rather having a varied score on each factor. The authors conclude that the factors come on the sides of a non-pharmacological and pharmacological axis, hence, it may therefore prove more useful to classify smokers on the single dimension of pharmacological addiction to nicotine rather than the in terms of their profiles on the above six ‘types’ of smoking.

Best and Hakstian (1978) concluded that smokers had similar reasons for smoking as suggested by their research, i.e. indulgent, automatic smoking and so on. However they argue that in general, the results suggest a more varied and differentiated pattern of smoking than has been suggested previously. The authors do provide useful justification for attempting to look for individual reasons for smoking, although they conclude that what is required is tailoring individual treatment techniques to individual reasons for smoking, but this requires both an appropriate conceptual model and valid clinical assessment procedures, and it is debatable whether this currently exists for motivation to smoke.

West and Russell (1985) used Russell et al’s (1974) smoking motivation questionnaire in an investigation into severity of cigarette withdrawal symptoms. They proposed five factors that predict some of the withdrawal symptoms associated with cessation of nicotine, as opposed to the six Russell originally proposed. These factors included dependent, stimulant, automatic, indulgent and sedative motivations to smoke. Stanaway and Watson (1980) also investigated Russell et al’s (1974) smoking motivation questionnaire, as well as Frith’s (1971) situational smoking questionnaire alongside participants smoking biographical details, in an attempt to establish what factors were found in common across each of the questionnaires. The authors found some congruence between the two measures, in particular addictive/automatic smoking. They pointed out however that there are a huge number of combinations of factors that possibly come out of such factor analysis.
Also one factor may sub-divide in one analysis but not another. The authors therefore concluded that although perhaps not consistent, the factors proposed do appear to be valid, in the sense that they appear to measure stable smoking behavioural constructs.

Shiffman (1993) argues that distinguishing types of smokers may help researchers understand the fundamental motivational basis of smoking behaviour. Practically as it seems that having this kind of information about smokers might be useful in adapting cessation programmes to individuals in order to improve cessation rates. However the validity of smoking typology measures is not clear in the literature, with different motivational measures not necessarily reporting the same factors. In some cases Shiffman believes scales do appear to be reliable in comparison with each other, the same factors often appearing in each scale albeit with different names. Shiffman argues that there may be only really two smoking motivation constructs, the first reflecting intrinsic pharmacological and emotional motives for smoking, and the second reflects peripheral or social motives for smoking. In conclusion about smoking typology measures Shiffman argues despite measures having poor criterion validity, smoking motivation measures do demonstrate some associations with clinically relevant variables such as smoking rate, withdrawal symptoms and cessation, and as such their use appears to be valid.

From the research described above it seems feasible to measure and to use motivation to smoke instruments in order to measure motivation to smoke amongst smokers. As there are a number of different measures the questionnaire booklet used here will incorporate 2 of them in an attempt to gain a reliable idea of what motivations to smoke participants have. The sample can then be split in order to investigate if exercise differentially reduces withdrawal symptoms after abstinence (this will be described in chapter 7) via a factor analysis of motivation questions. As dependence motivation to smoke has been found to be a consistent motivation to smoke amongst a variety of investigation, it is predicted this factor will occur among participants in this study, which will then be used in the second stage of this study.
6.1.2 Smoking cessation history and exercise

Previous work has established the beneficial effects of exercise on smoking withdrawal (Study one and Study two). An issue that as yet remains undetermined is if exercise is actually used in a real sense (i.e. that is in smokers everyday lives) to help them during smoking cessation. Marti and Vartiainen (1989) examined the association between frequency of leisure time exercise and smoking (as well as other cardiovascular risk factors) in a sample of adolescents. After medical examination, self-administered questionnaires, parental questionnaire and blood tests it was found that leisure time exercise was inversely related to daily smoking. This evidence suggests an association between exercise and smoking although this investigation is unclear as to what this relationship actually means. It is certainly not possible to say from this research that smokers use exercise to aid cessation attempts. Other researchers have also found similar relationships, Conway and Crohan (1988, 1992) examined the association between exercise activity, smoking behaviour and physical fitness in a large sample survey. They found that smoking was associated with lower levels of physical activity and lower physical endurance, both in terms of cardiovascular and muscular endurance. This has been reported elsewhere also (Biersner, Gunderson & Rahae, 1972; Coulson et al, 1997; Faulkner et al. 1987) but again this research predominantly fails to conclude much beyond a significant relationship.

Doherty, Steptoe, Rink, Kendrick and Hilton (1998) when looking at attitudes to exercise and smoking in cardiovascular recovery patients found that those patients that were trying to stop smoking were more open than those not thinking of stopping to using exercise to aid their cessation attempt. This suggests that smokers may be open to the idea of using exercise to aid cessation although this merely points to the possibility that they may use exercise, not if they actually did or not. This evidence suggests that not only are exercise and smoking inversely related but also that smokers may be open to using exercise as a smoking cessation aid. This consistent finding amongst different research studies of an inverse relationship between smoking and exercise behaviour may be due to a number of reasons, for example smoking related illness making exercise not possible, or undisclosed social factors
may be involved. This study will attempt to measure cessation history, and physical activity and exercise history in order to ascertain if they are significantly related. Although this is not the primary aim of this study it was decided that this research provided an opportunity to investigate these variables, albeit in a basic manner. This is not envisaged as a thorough investigation of this issue rather a brief, easily administered, and potentially informative first look at this relationship in a real world setting.

6.1.3 Expectation of exercise effects on mood

There is a possibility that the effects described in studies one and two could be partly explained via participant expectation. That is, participants are in some way expecting reductions in withdrawal symptoms following exercise and hence that is what they report, i.e. lower withdrawal and desire to smoke. Enjoyment and discomfort associated with exercise were found not to be related to withdrawal reductions, although specific beliefs about exercise and mood have not been investigated. There are a number of ways in which this relationship might work in terms of exercise and mood improvement and a number of mechanisms in which it is mediated. It could be that engaging in exercise engenders feelings of hopefulness associated with faith in improvements in mood, which in turn may reduce withdrawal and desire to smoke (Kirsch, 1985).

The belief in the effects of exercise on mood will be assessed in order to ascertain if expectation of the effects of acute exercise on mood in general effects this relationship. Specific belief in the effects of exercise on withdrawal symptoms will not be directly investigated as asking participants questions related to this at this stage may introduce confounds to the exercise part of this study. It has been found in the previous studies that enjoyment and discomfort felt during exercise were unrelated to how effective exercise was at reducing withdrawal. To support this result these variables will also be measured here, as well as belief in the effectiveness of exercise at improving mood.
6.1.4 Rationale for study 3a

This stage of the study aims to introduce a number of new measures into the methodology, specifically motivation to smoke measures, as well as self-reported measures of physical activity and smoking cessation history. From this it is hypothesized that participants will provide their self-reported motivations to smoke, and an insight into any possible relationship between actual exercise and smoking cessation history. It is hypothesised that the smoking motivation measures will provide a number of smoking motivation factors which will allow categorisation of participants via their motivational reasons for smoking. It is envisaged this will include a dependent motivation to smoke, as has been found consistently in previous research investigating motivation to smoke (these measures will be analysed further in the next stage of this experiment, which will be detailed in chapter 7). These variables will be measured using a survey sample, and a questionnaire booklet that encompasses the relevant measures.

6.1.5 Hypotheses

The specific hypotheses being tested within study 3a are listed below:

- There will be a significant relationship between smoking cessation attempts and physical activity behaviour.

- Factor analysis of smoking motivation measures will produce a number of components associated with smoking motivation that are consistent with previous analysis of smoking motivation measures.
6.2 METHOD

6.2.1 Participants

In total 202 smokers were given the questionnaire booklet, of this number 118 returned the completed questionnaire (this is a response rate of approximately 58.4%). The recruitment criteria were the same as that described in chapter four (see section 4.2.1). Of this group of participants 56 were male and 62 were female, their respective mean ages were 29.4 (11.7) and 31.1 (12.5) years old. All were classed as belonging to a white ethnic group. The study was approved by the University of Surrey’s committee on ethics.

6.2.2 Materials and procedure

Participants were given two information sheets (see appendix 16 and 17), one explaining the first stage of the experiment, the second detailing the second stage. Participants were also given a questionnaire booklet, which was a battery of a number of different psychometric measures, these will be described below. Some smokers were contacted via advertisements in the local press, these smokers were sent the information sheets and questionnaire booklet in a self-addressed envelope (the questionnaire booklet is presented in appendix 18).

Psychological measures

The measures are described below in the order by which they appear in the questionnaire booklet. The first part of the questionnaire booklet asked for demographic information, including age, sex and occupation. Measures that have been used in the previous studies included the Fagerström test for nicotine dependence (Heatherton et al, 1991; revised; see appendix 1), stages of change for physical activity (Marcus et al, 1992; see appendix 4), and the short form of the PANAS (Watson & Clark, 1992; see appendix 11) was used to measure trait affect. The following are descriptions of the psychological measures that were used for the first time here:
Motivation to quit and number of quit attempts. Participants completed two questions relating to how motivated they were to cease smoking at the time of filling out the questionnaire, and whether they intended to stop smoking in the future. The first question was 'do you want to stop smoking', and 'do you intend to make a serious attempt to stop smoking in the next three months'. It is via these two questions participants motivation to quit was measured. These are exploratory questions that were first used in study 2. Participants were then required to mark in a box on the questionnaire the number of times in the last year they had quit smoking for at least 24 hours. This latter question was part of the stages of change for smoking, as detailed below.

Stages of change for Smoking (Velicer et al, 1995). Smokers can be classified into one of five stages. 'Pre-contemplation' describes smokers who are not thinking about quitting. 'Contemplation' describes smokers who are thinking about quitting in the next 6 months and the 'preparation stage' describes smokers who plan to quit in the next 30 days and who have already made a quit attempt. Smokers had to answer the question 'Are you seriously thinking of quitting smoking?' to which they responded by ticking one of three boxes, 'yes, within the next 30 days'; 'yes, within the next three months'; and 'no, not thinking of quitting' (as inclusion criteria meant only current smokers were included in the study the first two stages of smoking behaviour change are not present within the participant population).

Smoking motives questionnaire (Russell et al, 1974; West & Russell, 1985). This questionnaire reports to measure a range of possible motives for smoking. These include dependent smoking, indulgent smoking, sedative smoking and stimulant smoking. The questionnaire consists of 18 questions. Participants respond to questions via a 5 point Likart scale. (1= not at all, 2= a bit, 3= sometimes, 4= often, 5= very much so).

Smoking by motives questions (West et al, 1999). This is a motivation to smoke measure designed to elicit information about motivations to smoke. The
questionnaire consists of 7 items rated on a 5 point scale (1= yes, very much, 2= yes, quite a bit, 3= yes, a little, 4= not really, 5= not at all).

**International physical activity questionnaire** (IPAQ; Craig & Russell, 2000; Sjostrom, Bull & Craig, 2002). This questionnaire is designed to obtain information regarding the physical activity the participant has taken part in over the course of a week via self-report. This is broken down into vigorous and moderate intensity activity, as well as walking and sitting. In each intensity category participants have to state, on a typical day of that week how many days, hours, and minutes they spent doing that intensity of physical activity (participants also are able to state if they do not know how much of that activity they do in each case). The IPAQ has been found to be a valid and reliable measure of physical activity (Craig, Marshall, Sjostrom, Bauman, Booth, et al, 2003). This also included a question taken from the Seven Day Physical Activity Recall Questionnaire that asks participants to compare the previous seven days activity with the previous three months, and to state how typical that level of physical activity is for them. This is reported via a five point Likert scale (1 = much less, 2 = less, 3 = about the same, 4 = more, 5 = much more).

**Attitudes to exercise questions:** These consist of three questions designed to determine participant believe in the psychological and physiological benefits of exercise. These questions were: ‘Exercise is very important for my physical health’ and ‘Exercise is very important for my mental health’, rated on a 5 point scale, (1= strongly disagree, 2= disagree, 3= neither agree or disagree, 4= agree or 5= strongly agree). The final question was ‘How much do you enjoy exercise’, rated on a scale (1= not at all, 2= a little, 3= somewhat, 4= very much so, 5= extremely). These were devised from personnel communication with Dr Michael Ussher (Ussher, 2002).

### 6.3 RESULTS

#### 6.3.1 Data Analysis

For measurements of motivation to smoke, factor analysis (FA) was conducted in order to identify common factors amongst smoking motivation measures. Also
correlational analysis and analysis of variance (ANOVA) were conducted in order to determine relationships between cessation and physical activity variables.

6.3.2 Sample baseline characteristics

Baseline characteristics of the sample are presented in table 6.1. Overall there were 54 males and 57 females.

Table 6.1: Mean (SD) values for participant self-reported characteristics (n=118)

<table>
<thead>
<tr>
<th>Baseline variable</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>30.5 (12.2)</td>
</tr>
<tr>
<td>Years smoked</td>
<td>13.2 (11.7)</td>
</tr>
<tr>
<td>Number of cigarettes smoked per day</td>
<td>14.8 (8.9)</td>
</tr>
<tr>
<td>Fagerström dependence measure (1-10)</td>
<td>4.3 (2.5)</td>
</tr>
<tr>
<td>Motivation to quit (0-4)</td>
<td>3.9 (1.3)</td>
</tr>
<tr>
<td>Trait Positive Affect (1-5)</td>
<td>2.4 (.8)</td>
</tr>
<tr>
<td>Trait Negative Affect (1 – 5)</td>
<td>3.3 (.7)</td>
</tr>
</tbody>
</table>

6.3.3 Stages of change for smoking and exercise

Stages of change for smoking and exercise behaviour were measured in all participants. No participants were in the action stage (had quit smoking within the last 6 months) or maintenance stage (had quit more than 6 months ago) of smoking behaviour change as this would mean they were not current smokers. Stages of change for smoking are presented in table 6.2 and stages of change for exercise are presented in table 6.3. Chi-square analysis for stages of change for exercise and smoking found no significant unique contribution of scores on motivational questionnaires.

Table 6.2: Percentage scores for stages of change for smoking

<table>
<thead>
<tr>
<th>Stage of change</th>
<th>No. of participants (n = 118)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation</td>
<td>12.7 (15)</td>
</tr>
<tr>
<td>Pre-contemplation</td>
<td>33.1 (39)</td>
</tr>
<tr>
<td>Contemplation</td>
<td>54.2 (64)</td>
</tr>
</tbody>
</table>
### Table 6.3: Percentage scores for stages of change for exercise

<table>
<thead>
<tr>
<th>Stage of change</th>
<th>No. of participants (n = 118)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation</td>
<td>26.3 (31)</td>
</tr>
<tr>
<td>Pre-contemplation</td>
<td>19.5 (23)</td>
</tr>
<tr>
<td>Contemplation</td>
<td>14.4 (17)</td>
</tr>
<tr>
<td>Action</td>
<td>16.9 (20)</td>
</tr>
<tr>
<td>Maintenance</td>
<td>22.9 (27)</td>
</tr>
</tbody>
</table>

#### 6.3.4 Factor analysis of motivation to smoke measures

The 18 items of the Smoking Motive Questionnaire (SMQ; West & Russell, 1985) were subjected to a Principle Components Analysis (PCA). Prior to performing PCA the suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above. The Kaiser-Meyer-Oklin value was .79, exceeding the recommended value of .6 (Kaiser, 1970, 1974), and the Bartletts test of sphericity (Bartlett, 1954) reached statistical significance (797.909, df =153, p<.001), supporting the factorability of the correlation matrix.

Principal components analysis revealed the presence of five components with eigenvalues exceeding one, explaining 31.3 per cent, 10.3 per cent, 8.6 per cent, 7.6 per cent and 6.4 per cent respectively. An inspection of the scree plot revealed a clear break after the second component (the scree plot is available in appendix 19) Using Catells (1966) scree test, it was decided to retain two components for further investigation. Direct oblim rotation (presented in table 6.4) revealed a simple structure, with both components showing a number of strong loadings substantially on only one component. The two factor solution explained a total of 48.2 per cent of the variance, with component one contributing 31.3 % and component two 10.3%.

The interpretation of the two components is based on similarities between the items that make up the factors (components). The original components proposed by Russell and West (1985), compared to the following: one appears to correspond to dependent, sedative and automatic motivations to smoke and component 2...
corresponds to indulgent and stimulant motivations to smoke. These suggest that component 1 refers to 'an automatic and dependent motivation to smoke' and component 2 a 'energy and pleasure' motivation to smoke. This interpretation of factors will be discussed in more detail later.

Table 6.4: Direct oblim rotation of two factor solution for SMQ items

<table>
<thead>
<tr>
<th>Item</th>
<th>Component 1</th>
<th>Component 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I get a definite craving to smoke when I have to stop for a while</td>
<td>.791</td>
<td></td>
</tr>
<tr>
<td>11. I find it difficult to go as long as an hour without smoking</td>
<td>.735</td>
<td></td>
</tr>
<tr>
<td>15. I get a real gnawing hunger to smoke when I haven't smoked for a while</td>
<td>.730</td>
<td></td>
</tr>
<tr>
<td>9. I smoke more when I am unhappy</td>
<td>.728</td>
<td></td>
</tr>
<tr>
<td>18. I light up a cigarette when I feel angry about something</td>
<td>.683</td>
<td></td>
</tr>
<tr>
<td>8. When I have run out of cigarettes I find it almost unbearable until I can get them</td>
<td>.682</td>
<td></td>
</tr>
<tr>
<td>17. I would find it difficult to go without smoking for as long as a week</td>
<td>.671</td>
<td></td>
</tr>
<tr>
<td>7. I smoke automatically without even being aware of it</td>
<td>.616</td>
<td></td>
</tr>
<tr>
<td>12. I find myself smoking without remembering lighting up</td>
<td>.537</td>
<td></td>
</tr>
<tr>
<td>2. I light up a cigarette without realising I still have one burning in the ash tray</td>
<td>.454</td>
<td></td>
</tr>
<tr>
<td>5. I smoke more when I am worried about something</td>
<td>.392</td>
<td>.791</td>
</tr>
<tr>
<td>13. I want to smoke most when I am comfortable and relaxed</td>
<td></td>
<td>.769</td>
</tr>
<tr>
<td>14. Smoking helps me to think and concentrate</td>
<td></td>
<td>.657</td>
</tr>
<tr>
<td>3. I like a cigarette best when I am having a quite rest</td>
<td></td>
<td>.613</td>
</tr>
<tr>
<td>6. I get a definite lift and feel more alert when smoking</td>
<td></td>
<td>.557</td>
</tr>
<tr>
<td>4. I get a definite pleasure whenever I smoke</td>
<td></td>
<td>.496</td>
</tr>
</tbody>
</table>

(Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization; blank spaces in the table indicate where a component loading was below .39)

Participants average score on these two components are presented in table 6.5. Correlations were computed to examine the relationship between the two components and other baseline variables. It was found that component 1 was significantly correlated with component 2 (.46, p<.01), to years smoked (.25, p < .05), number of cigarettes smoked per day (.55, p < .01), scores on the Fagerström nicotine
dependence scale (.65, p <.05) and scores for trait negative affect (.22, p<.05). Component 2 was significantly correlated with number of years smoked (.20, p<.05), number of cigarettes smoked per day (.26, p <.05), and scores on the Fagerstrom nicotine dependence scale (.32, p<.05). These correlations suggest that both factors are related in some way to dependence on nicotine and number of cigarettes smoked, factor 1 in particular, with larger significant correlations.

Table 6.5: Average scores on two components from initial factor analysis of SMQ

<table>
<thead>
<tr>
<th></th>
<th>Component 1 (1-5)</th>
<th>Component 2 (1-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>2.8 (.8)</td>
<td>3.1 (.8)</td>
</tr>
<tr>
<td>Females</td>
<td>2.8 (.7)</td>
<td>2.9 (.7)</td>
</tr>
<tr>
<td>Range</td>
<td>1.36 – 5.00</td>
<td>1.33 – 5.00</td>
</tr>
<tr>
<td>All participants</td>
<td>2.8 (.7)</td>
<td>3.1 (.8)</td>
</tr>
</tbody>
</table>

Another measure of smoking motivation was also included within the study, this consisted of West et al’s (1999) motivation to smoke questions. These 7 items were subjected to a Principle Components Analysis (PCA) using SPSS. Suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above. The Kaiser-Meyer-Oklin value was .691, exceeding the recommended value of .6 (Kaiser, 1970, 1974) and the Bartletts Test of Sphericity (Bartlett, 1954), reached statistical significance, supporting the factorability of the correlation matrix.

Principal components analysis revealed the presence of 2 components with eigenvalues exceeding one, explaining 36.5 per cent and 15.4 per cent respectively. Using Catells (1966) scree test, two components were retained for further investigation (the scree plot is available in appendix 20). Direct oblim rotation (presented in table 6.6) revealed a simple structure, with both components showing a number of strong loadings substantially on two components. The two factor solution explained a total of 51.6 per cent of the variance.
Table 6.6: Direct oblim rotation of two-factor solution for West et al (1999) smoking motivation questions.

<table>
<thead>
<tr>
<th>Item</th>
<th>Component 1</th>
<th>Component 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Do you smoke because you feel uncomfortable if you don't?</td>
<td>.790</td>
<td></td>
</tr>
<tr>
<td>4. Do you use smoking to help you to concentrate and stay alert?</td>
<td>.737</td>
<td></td>
</tr>
<tr>
<td>3. Do you use smoking to give you something to do when you are bored?</td>
<td>.639</td>
<td></td>
</tr>
<tr>
<td>6. Do you use smoking to help you to keep your weight down?</td>
<td>.494</td>
<td></td>
</tr>
<tr>
<td>2. Do you use smoking to help you socialise?</td>
<td></td>
<td>.746</td>
</tr>
<tr>
<td>1. Do you use smoking to help you cope with stress?</td>
<td>.613</td>
<td></td>
</tr>
<tr>
<td>7. Do you enjoy smoking?</td>
<td></td>
<td>.538</td>
</tr>
</tbody>
</table>

(Extraction Method: Principal Component Analysis, Rotation Method: Oblimin with Kaiser Normalization; spaces in the table indicate where a component loading was below .39)

The interpretation of the two components is based on an investigation of the original components proposed by West et al (1999). Component one corresponding to smoking to keeping weight down, being uncomfortable without smoking, and smoking to staying alert. Component 2 corresponds to the following motivations to smoke: smoking to do something, socialising and enjoyment of smoking. These suggest that component 1 refers to dependence and stimulation smoking motivation and component 2 smoking for pleasure and support. These interpretations will be discussed in more detail later.

The average score on these two components is presented in table 6.7. Correlations were computed to examine the relationship between the two components and other baseline variables. It was found that component 1 was significantly correlated to component 2 (.38, p<.05), to component 1 (.524, p<.01) and component 2 (.497, <.01) of the SMQ, number of cigarettes smoked per day (.277, <.05), and scores on the Fagerström nicotine dependence (.32, <.05). Component 2 was significantly correlated only with component 1 (.325, p<.05) and component 2 (.36, p<.05) of the SMQ scale (West & Russell, 1985). This second motivation to smoke questionnaire seems to correspond to the first in terms of interpretation of factors in certain aspects.
Table 6.7: Average scores on two components from initial factor analysis of West et al (1999) smoking motivation questions

<table>
<thead>
<tr>
<th></th>
<th>Component 1</th>
<th>Component 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>2.7 (.3)</td>
<td>3.5 (.3)</td>
</tr>
<tr>
<td>Females</td>
<td>2.9 (.3)</td>
<td>3.3 (.2)</td>
</tr>
<tr>
<td>Range</td>
<td>1.36 – 5</td>
<td>1.67 – 5</td>
</tr>
<tr>
<td>All participants</td>
<td>2.8 (.2)</td>
<td>3.4 (.2)</td>
</tr>
</tbody>
</table>

6.3.5 Cessation history and physical activity

Participants had attempted to quit smoking for 24 hours on average 4.5 (2.7) times or more over the past year. Participants’ levels of physical activity were measured using the International Physical Activity Questionnaire (Booth, 2000). The details of this questionnaire are presented below (see table 6.8). In terms of how typical weekly estimates of physical activity were compared to the previous three months 64.4% of participants reported that a week’s activity was ‘about the same’ as the previous three months activity level.

Table 6.8: Results from the IPAQ (n = 118)

<table>
<thead>
<tr>
<th>Questions on the IPAQ</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of days (per 7 days) vigorous physical activity</td>
<td>1.7 (.9)</td>
</tr>
<tr>
<td>Hours of vigorous activity on one of these days</td>
<td>.7 (.1)</td>
</tr>
<tr>
<td>Minutes of vigorous activity on one of these days</td>
<td>.007 (.03)</td>
</tr>
<tr>
<td>No. of participants who didn’t respond hrs/mins</td>
<td>6</td>
</tr>
<tr>
<td>No. of days (per 7 days) do moderate physical activity</td>
<td>2.2 (1.3)</td>
</tr>
<tr>
<td>Hours of moderate activity on one of these days</td>
<td>.59 (.12)</td>
</tr>
<tr>
<td>Minutes of moderate activity on one of these days</td>
<td>.59 (.55)</td>
</tr>
<tr>
<td>No. of participants who didn’t respond hrs/mins</td>
<td>14</td>
</tr>
<tr>
<td>No. of days (per 7 days) walk</td>
<td>5.3 (2.1)</td>
</tr>
<tr>
<td>Hours of walking activity on one of these days</td>
<td>.98 (.14)</td>
</tr>
<tr>
<td>Minutes of walking activity on one of these days</td>
<td>.51 (.15)</td>
</tr>
<tr>
<td>No. of participants who didn’t respond hrs/mins</td>
<td>8</td>
</tr>
<tr>
<td>Hours of sitting each day</td>
<td>4.94 (3.7)</td>
</tr>
<tr>
<td>Minutes of sitting on one of these days</td>
<td>.015 (.007)</td>
</tr>
<tr>
<td>No. of participants who didn’t respond hrs/mins</td>
<td>24</td>
</tr>
</tbody>
</table>
The questionnaire also asked how important participants felt exercise was for physiological and psychological health respectively. These were rated on a 5 point likart scale (1-5). Participants were also asked how much they enjoyed exercise. These scores are presented in table 6.9.

**Table 6.9: Participant ratings of enjoyment and belief in effects of exercise**

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean rating (scale 1–5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise Important Physical Health</td>
<td>4.4 (0.74)</td>
</tr>
<tr>
<td>Exercise important Psychological health</td>
<td>4.13 (0.85)</td>
</tr>
<tr>
<td>Enjoyment of exercise</td>
<td>3.20 (1.1)</td>
</tr>
</tbody>
</table>

Correlational analysis comparing history of quit attempts, with physical activity including walking, sitting, moderate and vigorous exercise estimates per week were found to be non-significant. This suggests that quit attempts are not significantly related to amount of physical activity done over the past week. Belief about the psychological and physiological benefits of doing physical activity was also found not to be significantly related to cessation history.

### 6.4 DISCUSSION

This study was conducted in order to attempt to measure smoking motivation and to investigate the relationship between smoking and exercise behaviour. Results from the factor analysis of two smoking motivation measures revealed a factor structure that was reasonably consistent across the two measures, and appeared to confirm findings related to smoking motivation from earlier research. A dependent and automatic motivation to smoke was found from this analysis. This is in line with previous research findings (Carton et al, 2000) and will be used in the second stage of this study to differentiate smokers by this motivation. Initial analysis of data from this investigation suggests that habitual levels of physical activity are not related to smoking cessation attempts. This suggests that exercise is not related to smoking cessation history, however due to the limitations of the sample used within this study this finding may have been expected.
6.4.1 Motivation to smoke

The main aim of this investigation was to use factor analysis (FA) on two motivations to smoke measures in order to attempt to determine motivation to smoke factors that could be used in stage 2 of this study. The first motivation questionnaire to undergo factor analysis was West and Russell's (1985) Smoking Motives Questionnaire (SMQ). From initial factor analysis it was revealed that two factors emerged that accounted for a significant proportion of the variance in the data. Factors were interpreted from examining the questions that constituted these two factors (and the factor structure proposed in West & Russell's original research). The first factor found in this study corresponded to dependent, sedative and automatic motivations to smoke and factor two corresponded to indulgent and stimulant motivations to smoke (from the original FA). Hence here they were interpreted as an automatic and dependent motivation to smoke, and energy and pleasure motivation to smoke.

Due to these comparisons and examination of the questions that make up the factors factor 1 could be considered an 'Addiction' factor. Questions seem to correspond to addiction criteria for smoking. For example questions include 'I get a definite craving to smoke when I have to stop for a while' and 'I get a real gnawing hunger to smoke when I haven't smoked for a while'. The other questions also appear to refer to difficulty in not smoking, adverse psychological symptoms like anxiety and anger when not being able to smoke and automatically smoking without conscious awareness. Participants scoring highly on this factor therefore seem mainly motivated to smoke by a heavy reliance on smoking to alleviate withdrawal symptoms and desire to smoke. These findings also correspond to suggestions about motivation to smoke made by some authors (Russell et al, 1974).

The second factor is conceptualised here as an energy and pleasure motivation to smoke, as questions that make up this factor appear to correspond to issues that are predominantly concerned with smoking for pleasure, for indulgent purposes and for stimulation. Examples of questions that comprise this factor include 'I get a definite lift and feel more alert when smoking' and 'I get a definite pleasure whenever I
smoke'. Both of these questions and the other questions that make up this factor are concerned with smoking for pleasure, to indulge the smoker and to enable the smoker to concentrate, and think better. Although West and Russell originally encompassed 5 factors, when comparing the solution for this questionnaire with another, newer motivation questionnaire, namely West et al.'s (1999) 7 motivation questions, similar factors were also observed. Again a factor analysis was conducted on this questionnaire and a two-factor solution presented the best solution for the data.

These two factors seemed to correspond to the two factors conceived for the SMQ, i.e. factor 1 seeming to correspond to items concerned with addiction to smoking ‘Do you smoke because you feel uncomfortable if you don’t?’ and smoking for stimulation ‘Do you use smoking to help you to concentrate and stay alert?’. The second factor consisted of items concerning enjoying and pleasure in smoking ‘Do you enjoy smoking?’ and stress and socialisation reasons for smoking ‘Do you use smoking to help you socialise?’ These two factors seem to roughly correspond to the two factors of addiction and stimulation that apply to the first motivation questionnaire. This second motivational questionnaire however includes a question about weight gain, which the SMQ does not include and it could be interpreted that this second measure has a number of items that do not ‘fit’ so well into this interpretation of the two measures. Future research should attempt to recruit more participants thus enabling an analysis of the two measures combined. Correlational analysis revealed significant relationships between these two factors and the first SMQ related factors. It also suggests that these factors are related to the same motivation to smoke factor structure.

Also analysis revealed that component 1 (automatic and dependent motivation to smoke) of the West and Russell (1985) SMQ was related to years smoked, amount of cigarettes smoked per day and scores on the Fagerström dependence measure. These are consistent with the factor measuring dependence and addiction to cigarettes and as such it is perhaps not so surprising that these relationships were found. The fact both factors appear to be associated with these variables might suggest that in general smoking motivation might be best assessed via these variables rather than the factor
structure proposed here. However as these relationships are only based on correlational analysis, it remains unclear how exactly these variables interact with smoking motivation. The information elicited about motivation from variables such as years smoked and number of cigarettes smoked at the most only indicates levels of addiction. The motivational factor structure proposed here seems to provide more information about smoker’s reasons for smoking. These findings are also in line with Shiffman’s (1993) assertion that smoking typology measures demonstrate some associations with clinically relevant variables such as smoking rate, desire to smoke, withdrawal symptoms, and smoking cessation. As study 1 reported that number of cigarettes and self-reported addiction to smoking were significantly related to effectiveness of exercise at reducing withdrawal, the dependence and automatic motivation to smoke measure found here will be used to investigate if smokers with high and low scores on this motivation respond differently to acute exercise.

6.4.2 Exercise and smoking cessation history

Another aim of this research was to establish if any relationship existed between self-reported habitual levels of physical activity and history of smoking cessation. Physical activity was recorded by an international physical activity scale, which has been found to be a reliable and valid measure of exercise participation (Craig et al, 2003). Cessation history was inferred from a question on the short form of the stages of change model for smoking, this was a one question item that asked participants the number of cessation attempts they had made over the past year. It was found that there was no significant relationship between reported levels of physical activity and cessation history. This data therefore suggests that cessation history was not related to exercise history, which may indicate that current exercise is not significantly related to past cessation attempts and that exercise performed on a daily basis does not seem to have an effect on smoking status. However these are only tentative conclusions as the sample were only analysed using correctional techniques, hence only potential relationships can be surmised from the data, rather than causal effects.

The fact no significant relationship was found between exercise and smoking behaviour was perhaps not so surprising considering the inclusion criteria for this study. Like study 1 and 2 participants had to be classed as sedentary, and as such
would therefore have limited weekly participation in exercise and physical activities. If the sample had been open to all smokers, regardless of amounts of physical activity an inverse relationship between smoking and exercise behaviour may have been found, like it has been elsewhere (Coulson et al, 1997; Hickey et al, 1975). Also, as mentioned above, the nature of the cessation history question included within this study only consisted of one item, asking participants the number of 24 hour or over cessation attempts made over the past year. As such this may not have provided a detailed enough idea of how many times participants have attempted to stop smoking.

The questionnaire was not designed to gain a detailed investigation of cessation history. Rather it was a measure that attempted to obtain a general idea of cessation from participants. With this data it was envisaged that if naturalistic exercise, whether for deliberate cessation purposes or just exercising in general, was related to cessation then some significant relationship would have been found between these variables. Previous research has established that physical activity and exercise is effective at reducing withdrawal (study I & 2) although research has not shown if this occurs naturally, i.e. if smokers use exercise to reduce withdrawal and aid cessation attempts. This study does not support this possibility at this stage although it does not rule out that either of the two possibilities may occur. Further research needs to investigate this, specifically using subjective, self-report techniques, like the one used here, but which elaborates on cessation history further.

6.5 CONCLUSIONS

The main aim of this part of the study was firstly, to measure motivation to smoke, and secondly to examine the relationship between habitual physical activity and cessation history. The questionnaire data suggested that two consistent underlying factors emerged from the motivation to smoke questions with an automatic and dependent motivation to smoke being found as predicted. Although by no means totally comprehensive this appears to provide a consistent analysis of the reasons for smoking by participants, in line with motivations to smoke reported in previous research. The second stage of this experiment will use this motivational variable to
determine if this motivation to smoke interacts with acute, moderate intensity, exercise at reducing withdrawal and desire to smoke.

Results from this questionnaire did not suggest that habitual exercise history was related to cessation attempts, although lack of in-depth information concerning cessation attempts implies this in a tentative conclusion at best. A more comprehensive investigation into this issue needs to be conducted in order to establish any links between smoking cessation success, and lifestyle physical activity in all smokers, not just sedentary smokers. The next chapter will use variables measured in this stage of the experiment in a similar exercise intervention as implemented in studies one and two. This will attempt to determine the relationship between motivation to smoke, and reductions in withdrawal and desire to smoke following an acute bout of moderate intensity exercise.
CHAPTER 7

STUDY 3b

7.1 INTRODUCTION

The previous chapter outlined the first stage of this research, which investigated smoking motivation and the relationship between exercise history and smoking cessation history. It was found that participants consistently reported motivational variables along a two-factor structure that accounted for a large majority of variance in motivational reasons for smoking. The factor found that was felt to be the most important was an automatic and dependent motivation to smoke. This factor was supported by analysis of two established motivational questionnaires. This stage of the investigation aims to use this motivational variable to determine if motivation to smoke interacts with the acute effects of moderate intensity exercise on smoking withdrawal symptoms and desire to smoke. The main aim of this study is to determine if sedentary smokers, who will complete the same exercise paradigm as used in chapter 5 will report withdrawal symptoms differently due to differences in motivational reasons for smoking. The secondary aim is to examine the role of expectation in this effect. Expectation of the effects of exercise on smoking withdrawal will be measured prior to taking part in exercise. The aim of this is to determine if expectation of the effects of exercise on withdrawal is related to how effective exercise is at reducing symptoms and desire to smoke.

7.1.1 Motivation to smoke and its relationship to exercise

Previous researchers have designed a number of measures that purport to measure different motivations to smoke (Spielberger & Jacobs, 1982; Pomerleau et al, 1993; West & Russell, 1985; West et al, 1999). These measures have been found to be reasonably consistent reliable, and the factors they measure are associated with various aspects of smoking behaviour. Carton et al (2000) found that common motivational factors amongst these measures were stimulant, indulgent,
psychosocial, sensiromotor, addictive, automatic and sedative motivations to smoke. In the previous chapter, two smoking motivation measures were used to determine motivation to smoke in a sample of sedentary smokers and two consistent motivational components appeared: automatic and dependent motivation to smoke and energy and pleasure motivation to smoke. Other factors have been reported in other research (for example West & Russell, 1985) with motivations such as smoking for stimulation and smoking to reduce weight (West et al, 1999). Questions relating to these kinds of constructs were included in the questionnaire booklet used in the previous chapter, although when an analysis of all these items was conducted they did not appear as separate components. As these factors seemed to also correspond to a factor analysis of another motivational measure (West et al, 1999), it seems acceptable to retain this component structure to discern motivation to smoke.

Study one found that those smokers who were more addicted to smoking and smoked more reported greater reductions in desire to smoke during exercise, compared to less addicted participants. Research into the effects of smoking withdrawal has consistently produced evidence to suggest that desire to smoke is the most consistent feature of the smoking withdrawal syndrome. It would therefore appear that factor one, automatic and dependent motivation to smoke will be the strongest motivation. Also due to the economic and time restrictions placed on participant recruitment here it proved difficult to conduct a study utilising multiple groups based on numerous motivations to smoke, with sufficient sample size to be methodologically sound. Therefore one construct from this initial analysis will be used here, it is felt this will be sufficient to provide useful information about smokers motivational characteristics and how these interact with exercise effects on withdrawal and desire to smoke. Using automatic and dependent motivation to smoke scores participants were split into low and high dependence motivation groups. Participants then took part in the same exercise procedure used in study two. Groups can then be compared, with an aim to determining if variance in motivation to smoke is related to exercise induced reductions in withdrawal and desire to smoke.
7.1.2 Expectation of exercise related mood affects

As yet it remains unclear within the smoking and exercise research literature whether expectation of the beneficial psychological effects of exercise is significantly related to reductions in smoking withdrawal and desire to smoke. Participants enjoyment and discomfort associated with doing exercise appears to be unrelated to exercise induced reductions in smoking withdrawal symptoms (see chap 5), this does not however explicitly investigate participant belief in the effects of exercise on smoking related mood and behaviour, and even more specifically expectation of the benefits of exercise on smoking withdrawal symptoms and desire to smoke. By measuring these variables it may be possibly to discern whether expectation is related to reductions in symptomology. If this is found to be the case then expectation of the effects of exercise on smoking may play a crucial, and potentially causal, role in the reductions of smoking withdrawal symptoms observed during and after exercise.

7.1.3 Rationale for study 3b

The main aim of this investigation is to determine whether automatic and dependent motivation to smoke is related to reductions in smoking withdrawal symptoms following acute bouts of moderate intensity exercise. In doing so it is predicted that this study will provide evidence for the possibility that certain types of smokers might benefit more from short bouts of moderate intensity exercise compared to others. Participant expectation of the benefits of exercise on smoking withdrawal and desire to smoke will also be investigated to determine if expectation influences the effects of exercise on withdrawal symptoms and desire to smoke.
7.1.5 Hypotheses

Specific hypotheses being tested in study 3b are listed below:

- There will be a significant difference between the low and high dependence motivation to smoke groups in terms of reductions observed in smoking withdrawal symptoms, and desire to smoke during, and directly following 10 minutes of moderate intensity exercise.

- Expectation of the effects of exercise on smoking withdrawal will be related to reductions observed in withdrawal symptoms and desire to smoke following exercise.

7.2 METHOD

7.2.1 Participants and materials

Participants were chosen from the initial sample that completed the questionnaire at stage one. Those scoring highest and lowest on factor 1 (automatic and dependent motivation to smoke) were contacted to take part in stage 2 of the study. Of 60 participants contacted from the original sample (n = 118), 16 did not wish to take part and a further 4 did not make their study appointment. In total 40 smokers completed the exercise procedure. The recruitment criteria was the same as Study 3a, as participants were recruited from this sample (see chapter 6, section 6.2.1 for details). Materials used for this stage of the experiment were exactly the same as those used in Study One and Two (see chapter 4, section 4.2.2 for details).
7.2.2 Psychological measures

Measures already used within previous studies will only be noted, new measures used here will be described in more detail. For more detail for measures already used refer back to previous chapters for a more detailed description of these measures.

Measures that have been used in the previous studies included the Fagerström test for nicotine dependence (Heatherton et al, 1991; see appendix 2), the Seven-Day Physical Activity Recall Questionnaire (Sallis, 1978; see appendix 3) and Stages of change for smoking (Velicer et al, 1995; see appendix 18) and stages of change for physical activity (Marcus et al, 1992; see appendix 18). The Positive and Negative Affect Schedule was utilised again (PANAS, Watson & Clark, 1992; see appendix 11). Enjoyment and discomfort questions were also administered after exercise. The Smoking motives questionnaire (Russell et al, 1974; West & Russell, 1985; see appendix 18) was also administered to participants again. The Borg Scale of Perceived Exertion (Borg, 1998; see appendix 5) was used to measure ratings of perceived exertion during exercise and the Mood and Physical Symptoms Questionnaire (MPS; West & Russell, 1985; see appendix 10) was used to measure common smoking withdrawal symptoms and desire to smoke.

The only new measure used in this study was the Credibility scale (Dunmore, Clark & Ehlers, 1999; see appendix 21). This scale was adapted in order to measure participants belief in the effectiveness of exercise at reducing smoking withdrawal symptoms and the use of exercise as a smoking cessation aid. Before completing these questions participants were told that these questions referred to the use of exercise as a smoking cessation aid. The scale consisted of three questions, ‘How logical do you consider this approach to smoking cessation to be’? ‘How certain are you that this method will be successful in reducing your desire to smoke and withdrawal symptoms?’ These questions were rated on a scale from 0 to 10 (0 = not at all and 10 = completely). A final question was asked ‘With what degree of confidence would you recommend this approach to a friend who is trying to stop
smoking? This final question was rated on a scale between 0 and 10 (0 = none at all, and 10 = total).

7.2.4 Procedure

Participants at stage one of the study were informed that they might be asked to participate in the second stage of the experiment if they initially indicated they were interested in taking part. From those that expressed an interest in taking part in the second stage of the experiment examination of scores on automatic and dependent motivation to smoke components was done (as discerned from SMQ: West & Russell, 1985), participants were then ranked in terms of their scores on this factor. Those that scored the highest and lowest on automatic and dependent motivation to smoke were contacted to take part. This was calculated using median splits.

Participants were first asked the 8 questions of the Physical Activity Readiness Questionnaire (PAR-Q), a preliminary screening tool for exercise prescription and testing. This was to determine whether the participants were fit and healthy enough to take part in 10 minutes of moderate intensity exercise. If participants had any contra-indications then they were told they could not take part in the experiment. At this point participants CO was measured to ensure that they were smokers, a reading of 10 and above was considered sufficient evidence that they were a smoker. A pre-abstinence resting heart rate was also taken at this point, this was required for exercise intensity calculations. An appointment was then made for the actual testing session. Participants were informed they were to completely refrain from smoking from 11 p.m. the night prior to the test day, and that they had to remain abstinent up to completing the test procedure. Participants were told this would be confirmed via a further CO reading at that time.

At testing participants CO was measured again. A reading of 10 or below was considered an acceptable level of CO for a smoker that had been abstinent for between 11-15 hours (Ussher et al, 2003), this criterion was used in Study One and Two also. Resting heart rate was also measured again at this point. Participants then
signed a written consent form and were made aware verbally that they would be able to withdraw from the experiment at any time if they wished, without having to explain why. Participants then completed the seven-day physical activity recall questionnaire. After this the credibility scale and the smoking motives questionnaire (SMQ; time 2) were all completed. At this point participants were fitted with a polar heart rate monitor (Polar advantage©) and were told that their heart rate would be continuously measured throughout the experimental period. The polar watch interface was not visible to participants during the experimental period. The exercise procedure implemented for all participants was the same to that used in Study Two (see exercise section of 5.2.3 for a full description of this procedure). The only difference in the procedure utilised here was that participants continuously pedalled throughout administration of measures during the exercise. Figure 7.1 illustrates the timing of psychological measure administration. At the end of the 30 minutes study period participants were given a debriefing sheet (appendix 22) and paid the sum of £15.00 for their participation.

Figure 7.1: Study 3b: timing of instrument administration

![Figure 7.1: Study 3b: timing of instrument administration](image-url)
7.3 RESULTS

7.3.1 Motivational differences between groups

Factor analysis of the SMQ from stage 1 of this study was used to differentiate the sample into two groups. Factor scores were calculated by addition of those items that loaded highly on each factor and taking the mean score. Groups were discerned from median splits of factor 1, median 2.85, scores from 0-2.85 were classed as group 1 (low automatic and dependent motivation to smoke) and from 2.86 – 5 as group 2 (high automatic and dependent motivation to smoke). Paired sample t-tests were performed on all 18 questions of the SMQ at time 1 and time 2. This was an attempt to determine whether participants were consistent in their reporting of motivational variables on the SMQ prior to the experiment compared to SMQ administration just prior to exercise. No significant differences were observed between scores on all the items of the SMQ at time 1 or time 2. Correlational analysis revealed a significant relationship between SMQ question 1 at time 1, and SMQ question 1 at time 2 and so on for all questions of the SMQ. This analysis suggests that scoring on items of the SMQ was consistent within this sample across time (the average time between completing the SMQ at time 1 and at time 2 was 1 month).

Mean scores on the automatic and dependent motivation to smoke for each of the groups are presented in table 7.1. Also in table 7.1 are presented demographic variables for each respective group. T-tests were conducted in order to determine whether there were any significant differences between the groups on these variables. A significant difference was observed between the groups for scores on factor 1 of the SMQ. As the groups are based on the division by factor 1 it is expected that the groups would be significantly different between scores on these variables. It was also found that scores on the Fagerström dependence measure were also significantly different between motivation groups. As dependence is a major feature of the division of the groups then this is also expected. No significant differences were observed between the groups on any other baseline variables.
Table 7.1: Mean scores SMQ factors and demographic variables by group

<table>
<thead>
<tr>
<th></th>
<th>Group 1 – Low (n = 21)</th>
<th>Group 2 – High (n = 19)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>24.3 (8.1)</td>
<td>24.3 (5.1)</td>
<td>ns</td>
</tr>
<tr>
<td>Years smoked</td>
<td>7.7 (5.7)</td>
<td>9.2 (3.9)</td>
<td>ns</td>
</tr>
<tr>
<td>No. cigarettes per day</td>
<td>13.6 (3.3)</td>
<td>15.6 (4.7)</td>
<td>ns</td>
</tr>
<tr>
<td>Fagerström dependence total score</td>
<td>3.3 (1.4)</td>
<td>5.0 (1.8)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Trait Positive Affect (tPA)</td>
<td>17.4 (3.1)</td>
<td>16.5 (2.8)</td>
<td>ns</td>
</tr>
<tr>
<td>Trait Negative Affect (tNA)</td>
<td>11.3 (4.7)</td>
<td>12.4 (4.9)</td>
<td>ns</td>
</tr>
<tr>
<td>Automatic/Dependent motivation to smoke</td>
<td>2.3 (.41)</td>
<td>3.5 (.31)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Body Mass Index (BMI)</td>
<td>24.5 (3.4)</td>
<td>26.7 (4.7)</td>
<td>ns</td>
</tr>
<tr>
<td>Co Time 1</td>
<td>29.1 (8.7)</td>
<td>27.3 (9.8)</td>
<td>ns</td>
</tr>
<tr>
<td>Co Time 2</td>
<td>5.3 (3.3)</td>
<td>6.6 (3.1)</td>
<td>ns</td>
</tr>
<tr>
<td>Resting HR (pre- cessation)</td>
<td>72.5 (10.6)</td>
<td>73.4 (13.9)</td>
<td>ns</td>
</tr>
<tr>
<td>Resting HR (post-cessation)</td>
<td>71.5 (10.1)</td>
<td>71.1 (11.4)</td>
<td>ns</td>
</tr>
</tbody>
</table>

7.3.2 RPE and heart rate

Ratings of perceived exertion were measured at 2.5 and 7.5 minutes into the 10-minute period of moderate intensity exercise. Table 7.2 shows mean RPE and heart rate during exercise for both groups. Within the low dependence motivation to smoke group mean RPE scores correspond to somewhat hard on the Borg scale. Paired sample t-tests indicated that RPE at 2.5 was significantly lower than RPE at 7.5 minutes (t (20) = -2.4, p< 0.05). Paired sample t-tests also indicated that heart rate at 2.5 compared to HR at 7.5 minutes was significantly higher (t (20) = -4.1, p<. 0.01). Within the high dependence motivation to smoke group mean RPE scores correspond to somewhat hard on the Borg scale. Paired sample t-tests indicated that there were significant differences between RPE at 2.5 and 7.5 minutes (t (19) = -3.890, p< .01). Paired sample t-tests indicated that heart rate at 2.5 and at 7.5 minutes were not significantly different (t (19) = -1.4, p = .162). Paired sample t-tests indicated that resting heart rate prior to abstinence was significantly higher compared to resting heart rate after 12-15 hours of smoking abstinence (t (39) = 2.0, p < .05) in both
groups. No significant differences were seen between RPE and heart rate comparing low and high groups with each other.

**Table 7.2:** Mean (SD) of ratings of perceived exertion and average heart rate during exercise

<table>
<thead>
<tr>
<th></th>
<th>High (n = 21)</th>
<th>Low (n = 19)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPE 2.5 mins</td>
<td>12.5 (1.39)</td>
<td>12.9 (1.79)</td>
<td>ns</td>
</tr>
<tr>
<td>RPE 7.5 mins</td>
<td>14.2 (2.1)</td>
<td>14.0 (2.12)</td>
<td>ns</td>
</tr>
<tr>
<td>HR 2.5 mins</td>
<td>127.2 (14.5)</td>
<td>128.3 (12.3)</td>
<td>ns</td>
</tr>
<tr>
<td>HR 7.5 mins</td>
<td>126.5 (12.8)</td>
<td>126.4 (10.8)</td>
<td>ns</td>
</tr>
</tbody>
</table>

7.3.3 Withdrawal symptoms and desire to smoke

Ratings of withdrawal were taken (using the MPS) at 7 time periods. For ease of exposition the results of the MPS items are presented together (see table 7.3). Repeated measures ANOVA’s indicated that there were significant main effects of time for desire for a cigarette, irritability, depression, tension, restlessness, difficulty concentrating, stress and strength of desire to smoke. Significant main effects of group were found for desire to smoke and strength of desire to smoke. No significant main effect for group was found for irritability, depression, tension, restlessness, difficulty concentrating and stress. A significant group by time effect was found for tension only. Mean ratings on each of the eight questions on the MPS and the Desire to smoke item of the Tiffany item are shown in figure 7.2 (a-h).
Table 7.3: F values, degrees of freedom and significant levels of the repeated measure ANOVA

<table>
<thead>
<tr>
<th>Time</th>
<th>Group</th>
<th>Time * group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1) Desire for a cigarette</td>
<td>5.097 6 &lt;.001</td>
<td>7.622 1 &lt;.01</td>
</tr>
<tr>
<td>Q2) Irritability</td>
<td>5.873 6 &lt;.001</td>
<td>.748 1 = .393</td>
</tr>
<tr>
<td>Q3) Depression</td>
<td>5.586 6 &lt;.001</td>
<td>.200 1 = .657</td>
</tr>
<tr>
<td>Q4) Tension</td>
<td>8.790 6 &lt;.001</td>
<td>.003 1 = .960</td>
</tr>
<tr>
<td>Q5) Restlessness</td>
<td>3.277 6 &lt;.01</td>
<td>3.602 1 = .065</td>
</tr>
<tr>
<td>Q6) Difficulty concentrating</td>
<td>2.117 6 &lt;.05</td>
<td>1.969 1 = .169</td>
</tr>
<tr>
<td>Q7) Stress</td>
<td>9.121 6 &lt;.001</td>
<td>2.898 1 = .097</td>
</tr>
<tr>
<td>Q8) Strength of desire to smoke</td>
<td>13.651 6 &lt;.001</td>
<td>10.493 1 &lt; .01</td>
</tr>
</tbody>
</table>

Fig. 7.2 a-h: Ratings of withdrawal symptoms and desire to smoke at each measurement time (high=7, low=1). a) Desire to smoke. b) Irritability. c) Depression. d) Tension. e) Restlessness. f) Difficulty concentrating. g) Stress. h) Strength of desire to smoke.

Fig 7.2 a) Desire for a cigarette
Fig 7.2. b) Irritability

Fig 7.2. c) Depression

Fig 7.2. d) Tension
Fig 7.2. e) Restlessness

Fig 7.2. f) Difficulty concentrating

Fig 7.2. g) Stress
Eight planned comparison t-tests were calculated to compare measures of smoking withdrawal symptoms between baseline ratings and each respective time period (5, 10, 15, 20, 25 and 30 minutes) for both low and high dependence motivation groups. Due to the high number of post-hoc t-tests carried out (6 t-tests for each item of the MPS) a p<.008 significance level was adopted (Bonferroni t, 0.05/6 = .008). Table 7.3 illustrates these results. For the low dependence motivation group no significant differences were found from baseline at any time point for desire for a cigarette, irritability, restlessness and difficulty concentrating. For depression significant differences from baseline were found at 20, 25 and 30 minutes (lower than baseline), no significant difference was observed at 5, 10 and 15 minutes. For tension significant differences (lower) to baseline were found at 25 and 30 minutes, no significant differences were found at 5, 10, 15 and 20 minutes. Stress was significantly lower at 30 minutes but no other time point. Strength of desire to smoke was significantly lower at 15 and 20 minutes but not at 5, 10, 25 and 30 minutes.

For the high dependence motivation group no significant differences were observed for desire for a cigarette, depression and difficulty concentrating at any time point. Irritability was found to be significantly lower than baseline at 20 minutes but no other time point. Tension was found to be significantly different (lower than baseline) at 15, 20, 25 and 30 minutes, no significant difference was found at 5 and 10 minutes. Restlessness was significantly different (lower) at 20 minutes but no other time period. Stress was significantly different lower at 20, 25 and 30 minutes.
but not at 5, 10 and 15 minutes. Strength of desire to smoke was significantly lower compared to baseline at 15 and 20 minutes but not at 5, 10, 25 and 30 minutes.

Table 7.4: The significance of comparisons of baseline ratings with each subsequent measurement time for withdrawal symptoms and desire to smoke

<table>
<thead>
<tr>
<th>Q1) Desire for a cigarette</th>
<th>Low</th>
<th>ns</th>
<th>ns</th>
<th>ns</th>
<th>ns</th>
<th>ns</th>
<th>ns</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td></td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Q2) Irritability</td>
<td>Low</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>High</td>
<td></td>
<td>ns</td>
<td>ns</td>
<td>ns ***</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Q3) Depression</td>
<td>Low</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>High</td>
<td></td>
<td>ns</td>
<td>ns</td>
<td>ns **</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Q4) Tension</td>
<td>Low</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns ***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>High</td>
<td></td>
<td>ns</td>
<td>ns</td>
<td>ns ***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Q5) Restlessness</td>
<td>Low</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
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<tr>
<td>High</td>
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<td>ns</td>
<td>ns</td>
<td>ns ***</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Q6) Concentration</td>
<td>Low</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
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<tr>
<td>High</td>
<td></td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Q7) Stress to smoke</td>
<td>Low</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns ***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>High</td>
<td></td>
<td>ns</td>
<td>ns</td>
<td>ns ***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Q8) Strength of desire to smoke</td>
<td>Low</td>
<td>ns</td>
<td>ns</td>
<td>ns ***</td>
<td>***</td>
<td>***</td>
<td>ns</td>
</tr>
<tr>
<td>High</td>
<td></td>
<td>ns</td>
<td>ns</td>
<td>ns ***</td>
<td>***</td>
<td>***</td>
<td>ns</td>
</tr>
</tbody>
</table>

(*** = significantly different from baseline p<.001; ns = not significantly different from baseline; low = low automatic and dependent motivation to smoke, high = high automatic and dependent motivation to smoke)

7.3.4 Effects of exercise on withdrawal: groups combined

As analysis of the motivation groups revealed few differences in withdrawal symptoms and desire to smoke across time, an analysis was performed on all participants regardless of automatic and dependent motivation to smoke scores. Eight paired sample t-tests were calculated to compare measures of smoking withdrawal symptoms between baseline ratings and each respective time period (5, 10, 15, 20, 25 and 30 minutes) for all participants grouped together. Due to the large number of t-
tests carried out a p < 0.008 was adopted (Bonferroni correction 0.05/6 = .008). Table 7.5 illustrates these results. It was found that compared to baseline ratings, desire for a cigarette was significantly different from baseline at 15, 20, 25 and 30 minutes but not at 5 and 10 minutes. Irritability compared to baseline ratings was found to be significantly different from baseline at 20 minutes. Depression and tension were significantly different (lower) at 20, 25 and 30 minutes.

No significant difference was found for depression or tension at 5, 10 and 15 minutes. Restlessness was only significantly lower compared to baseline at 20 minutes, no significant difference was found at any other time point. Baseline ratings of difficulty concentrating were not found to be significantly different at any time point. It was found that compared to baseline ratings, stress was significantly different (lower) from baseline at 20, 25 and 30 minutes but not at 5, 10 and 15 minutes. Strength of desire to smoke was significantly different from baseline (lower) at 15, 20, 25 and 30 minutes. No significant differences were found at 5 and 10. When comparing significant differences in the groups combined to groups separated via motivation to smoke, a greater number of significant differences were observed in this combined sample.

Table 7.5: The significance of comparisons of baseline ratings with each subsequent measurement time for withdrawal symptoms and desire to smoke

<table>
<thead>
<tr>
<th></th>
<th>5 min Rest</th>
<th>10 min Rest</th>
<th>15 min Exercise</th>
<th>20 min Exercise</th>
<th>25 min Rest</th>
<th>30 min Rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1 Desire for a cigarette</td>
<td>ns</td>
<td>ns</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>**</td>
</tr>
<tr>
<td>Q2 Irritability</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>**</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Q3 Depression</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Q4 Tension</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>**</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Q5 Restlessness</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>**</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Q6 Difficulty concentrating</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Q7 Stress</td>
<td>ns</td>
<td>ns</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Q8 Strength of desire to smoke</td>
<td>ns</td>
<td>ns</td>
<td>***</td>
<td>***</td>
<td>**</td>
<td>**</td>
</tr>
</tbody>
</table>

(*** = significantly different from baseline p < 0.001; ns = not significantly different from baseline)
7.3.5 Positive and negative affect

Positive and negative affect were measured at the same time points as the MPS. Results from repeated measures ANOVA are presented in table 7.6. A significant main effect of time for PA was observed but no main effect of group by time, or group was found, similarly for NA a significant main effect of time was found. No significant main effect of time by group, or group, was found. Figure 7.3 a-b) illustrates mean scores on PA and NA (groups are combined here as no main effect of groups was found).

Table 7.6: F values, degrees of freedom and significant levels of the repeated measure ANOVA

<table>
<thead>
<tr>
<th></th>
<th>F value</th>
<th>df</th>
<th>P value</th>
<th>F value</th>
<th>df</th>
<th>P value</th>
<th>F value</th>
<th>df</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive affect</td>
<td>6.228</td>
<td>6</td>
<td>&lt;.001</td>
<td>.004</td>
<td>1</td>
<td>.953</td>
<td>.773</td>
<td>6</td>
<td>.59</td>
</tr>
<tr>
<td>Negative affect</td>
<td>10.213</td>
<td>6</td>
<td>&lt;.001</td>
<td>.055</td>
<td>1</td>
<td>.815</td>
<td>.242</td>
<td>6</td>
<td>.962</td>
</tr>
</tbody>
</table>

Fig. 7.3 a-b): Ratings of positive and negative affect across time

Fig. 8.3 a) Positive affect
As significant main effects of time were found for both NA and PA further analysis was conducted. Table 7.7 and 7.8 illustrate correlations between negative and positive affect and items of the MPS across time. As no main group effects were observed the groups have been combined into one sample. For positive affect depression was significantly related to PA at 15 and 25 minutes, all other times were non-significant. Tension was significantly related to PA at 25 minutes only and stress was significantly related to PA at 20 and 30 minutes. All other symptoms and time points were non-significant. For negative affect and desire for a cigarette, and strength of desire to smoke items, no significant relationships were observed. For depression, tension, restlessness and stress a significant relationship with NA was found at all time points. Scores on irritability were significantly related to negative affect at all time points except at 15 minutes. Tension was significantly related to NA at all time points except 20 minutes. NA was significantly related to difficulty concentrating at baseline, 5, 10, 25 and 30 minutes, but not at 15 and 20 minutes.

In the first stage of the study trait positive and negative affect were measured. In order to determine if trait positive and negative affect, and state negative and positive affect, were significantly different form each other paired sample t-tests were performed. A significant difference between trait positive affect and state positive affect were found (t (39) = 6.8, p < .001). A significant difference was also observed between trait and state negative affect (t (39) = 4.005, p < .001), trait affect being lower than state affect.
Table 7.7: Correlations between PA and MPS items

<table>
<thead>
<tr>
<th>MPS item</th>
<th>PA t1</th>
<th>PA t2</th>
<th>PA t3</th>
<th>PA t4</th>
<th>PA t5</th>
<th>PA t6</th>
<th>PA t7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1) Desire to smoke a cigarette</td>
<td>-.060</td>
<td>-.094</td>
<td>.120</td>
<td>-.129</td>
<td>-.089</td>
<td>-.189</td>
<td>-.069</td>
</tr>
<tr>
<td>Q2) Irritability</td>
<td>-.075</td>
<td>-.117</td>
<td>.088</td>
<td>.289</td>
<td>.222</td>
<td>-.075</td>
<td>.020</td>
</tr>
<tr>
<td>Q3) Depression</td>
<td>.061</td>
<td>.192</td>
<td>.147</td>
<td>.337*</td>
<td>.261</td>
<td>.328*</td>
<td>.177</td>
</tr>
<tr>
<td>Q4) Tension</td>
<td>.182</td>
<td>-.031</td>
<td>-.019</td>
<td>.043</td>
<td>.233</td>
<td>.314*</td>
<td>.270</td>
</tr>
<tr>
<td>Q5) Restlessness</td>
<td>-.123</td>
<td>.037</td>
<td>.232</td>
<td>.136</td>
<td>.055</td>
<td>.218</td>
<td>.301</td>
</tr>
<tr>
<td>Q6) Difficulty concentrating</td>
<td>.121</td>
<td>.035</td>
<td>.139</td>
<td>.094</td>
<td>.242</td>
<td>.235</td>
<td>.256</td>
</tr>
<tr>
<td>Q7) Stress</td>
<td>.137</td>
<td>.065</td>
<td>.231</td>
<td>.243</td>
<td>.331*</td>
<td>.142</td>
<td>.327*</td>
</tr>
<tr>
<td>Q8) Strength of desire to smoke</td>
<td>-.058</td>
<td>-.097</td>
<td>.138</td>
<td>-.149</td>
<td>-.106</td>
<td>-.104</td>
<td>-.005</td>
</tr>
</tbody>
</table>

Table 7.8: Correlations between positive affect (NA) and MPS items

<table>
<thead>
<tr>
<th>MPS item</th>
<th>NA t1</th>
<th>NA t2</th>
<th>NA t3</th>
<th>NA t4</th>
<th>NA t5</th>
<th>NA t6</th>
<th>NA t7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1) Desire to smoke a cigarette</td>
<td>.227</td>
<td>.257</td>
<td>.285</td>
<td>.150</td>
<td>.150</td>
<td>.220</td>
<td>.310</td>
</tr>
<tr>
<td>Q2) Irritability</td>
<td>.484**</td>
<td>.454**</td>
<td>.533**</td>
<td>.230</td>
<td>.484**</td>
<td>.300</td>
<td>.409*</td>
</tr>
<tr>
<td>Q3) Depression</td>
<td>.473**</td>
<td>.694**</td>
<td>.661**</td>
<td>.581**</td>
<td>.573**</td>
<td>.492**</td>
<td>.440*</td>
</tr>
<tr>
<td>Q4) Tension</td>
<td>.497**</td>
<td>.624**</td>
<td>.530**</td>
<td>.321*</td>
<td>.630**</td>
<td>.668**</td>
<td>.498**</td>
</tr>
<tr>
<td>Q5) Restlessness</td>
<td>.468**</td>
<td>.441*</td>
<td>.501**</td>
<td>.282</td>
<td>.435**</td>
<td>.400*</td>
<td>.452**</td>
</tr>
<tr>
<td>Q6) Difficulty concentrating</td>
<td>.560**</td>
<td>.686**</td>
<td>.473**</td>
<td>.248</td>
<td>.165</td>
<td>.346*</td>
<td>.414**</td>
</tr>
<tr>
<td>Q7) Stress</td>
<td>.514**</td>
<td>.516**</td>
<td>.527*</td>
<td>.466**</td>
<td>.493**</td>
<td>.392*</td>
<td>.469*</td>
</tr>
<tr>
<td>Q8) Strength of Desire to smoke</td>
<td>.213</td>
<td>.263</td>
<td>.222</td>
<td>.174</td>
<td>.133</td>
<td>.236</td>
<td>.201</td>
</tr>
</tbody>
</table>

7.3.6 Comparison of reductions in symptoms

The analysis described in section 7.3.3 assesses symptoms in each group compared to their baseline readings. With this approach it is still possible that a non-significant tendency for a difference between scores at baseline could affect the change score at each further time point. In order to assess this change scores were calculated i.e. ratings at 5 minutes minus baseline, ratings at 10 minutes minus baseline and so on (as was done in Study One and Two). These change scores for each group were used...
in repeated measures ANOVA. When comparing this new analysis with the analysis of MPS items presented in section 7.3.4 main effects are identical (reported in appendix 23). As this was found to be the case it was felt further planned comparison t-tests would not be required.

7.3.7 Discomfort and enjoyment of exercise and expectation

Table 7.9 illustrates information for each group on self-reported enjoyment and discomfort of exercise, and scores on the expectation of the effects of exercise on smoking cessation and withdrawal symptoms. Reliability analysis revealed a Cronbach alpha score of .76 for the expectation scale. This suggests this scale of expectation is reliable within this sample.

Table 7.9: Table showing scores on enjoyment, discomfort and credibility scales

<table>
<thead>
<tr>
<th>Items</th>
<th>Low Dependence motivation Group</th>
<th>High Dependence Motivation Group</th>
<th>Total (both groups)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enjoyment of exercise (scale 1-5)</td>
<td>2.95 (.80)</td>
<td>2.95 (.91)</td>
<td>2.95 (.85)</td>
<td>ns</td>
</tr>
<tr>
<td>Discomfort of exercise (scale 1-5)</td>
<td>2.05 (.92)</td>
<td>2.00 (.82)</td>
<td>2.03 (.86)</td>
<td>ns</td>
</tr>
<tr>
<td>Credibility scale q1) (0-10)</td>
<td>5.67 (2.6)</td>
<td>6.26 (2.0)</td>
<td>5.95 (2.3)</td>
<td>ns</td>
</tr>
<tr>
<td>Credibility scale q2) (0-10)</td>
<td>4.95 (2.1)</td>
<td>3.95 (1.8)</td>
<td>4.47 (2.0)</td>
<td>ns</td>
</tr>
<tr>
<td>Credibility scale q3) (0-10)</td>
<td>5.10 (2.8)</td>
<td>4.68 (1.9)</td>
<td>4.90 (2.4)</td>
<td>ns</td>
</tr>
<tr>
<td>Total Credibility scale</td>
<td>5.23 (2.2)</td>
<td>4.96 (1.4)</td>
<td>5.10 (1.8)</td>
<td>ns</td>
</tr>
</tbody>
</table>

Correlational analysis was conducted to determine if enjoyment, discomfort and expectation of the effects of exercise on smoking withdrawal were related to ratings of withdrawal symptoms following exercise. As no significant differences were observed between the groups on any withdrawal symptoms groups were combined for this analysis. Enjoyment and discomfort associated with exercise was found to be unrelated to reductions in withdrawal symptoms or desire to smoke at any time point.
In terms of scores on the expectation scale no significant relationships were observed between scores on question 1 of the credibility scale and any symptom. Scores on question 2 ("How certain are you that this method will be successful in reducing your desire to smoke and withdrawal symptoms?") were significantly related to change scores for the desire to smoke question at 20 minutes (.43, p<.05). On question 3 of the credibility scale ("With what degree of confidence would you recommend this approach to a friend who is trying to stop smoking") significant relationships were observed with desire to smoke at 10 (.49, p<.05), 15 (.68, p<.01), 20 (.63, p<.01) and 25 minutes (.54, p<.01). Question 3 was also significantly related to change scores on strength of desire to smoke at 15 (.49, p<.05) minutes. No other significant relationships were observed for any of the MPS items. Total scores on the credibility scale was significantly related reductions in desire for a cigarette at 15 (.53, p<.05) and 20 (.52, p<.05) minutes. These suggest that there is a significant relationship between expectation of exercise reducing withdrawal symptoms, and actual reductions in desire to smoke during exercise.

7.4 DISCUSSION

Using a measure of automatic and dependent motivation to smoke this study investigated if automatic and dependent motivation to smoke, and reductions in withdrawal and desire to smoke following exercise, were significantly related. It was found that smokers in the high dependence motivation to smoke group did report larger decreases in desire to smoke compared to those smokers with lower dependence motivations to smoke. Therefore this suggests that smokers with high motivation to smoke may benefit more from exercise in reducing desire to smoke during withdrawal. However, this was not found for other withdrawal symptoms. This indicates that acute bouts of moderate intensity exercise are equally effective at reducing common smoking withdrawal symptoms regardless of dependent motivation to smoke. It was also found that positive and negative affect was not significantly related to withdrawal symptoms and desire to smoke. This supports the findings of Study Two. Expectation of the effects of exercise on smoking withdrawal symptoms and desire to smoke were found to be significantly related to reductions in
desire for a cigarette and strength of desire to smoke. This suggests expectation of exercise reducing smoking related withdrawal symptoms is related to actual changes in ratings over time.

7.4.1 Motivation to smoke

The most recent exercise and smoking research has provided evidence of the beneficial effects of moderate intensity exercise on smoking withdrawal symptoms (Ussher et al, 2001). Study One and Two has further investigated the relationship between smoking and exercise, and have drawn parsimonious conclusions. This body of research however has yet to identify if any particular feature of smokers themselves might influence exercise effects on withdrawal symptoms and desire to smoke. Findings presented in Study One suggest that greater reductions in symptoms following exercise are observed in those smokers who smoke more cigarettes per day and who self-report to be more addictive to smoking. This could potentially indicate that some smokers will benefit more from the use of exercise as a smoking cessation aid compared to others. Strecher, Kreuter, Den Boer, Korbin, Hospers et al (1994) found that tailoring cessation techniques increased cessation success compared to a standardised cessation programme. If exercise were more effective at reducing withdrawal in some smokers compared to others then tailoring exercise interventions to these smokers would seem appropriate.

Results from this study did not find any difference between participants in terms of their reported withdrawal symptoms, automatic and dependent motivation did not influence the effectiveness of exercise at reducing common withdrawal. As this was found to be the case it appears that smokers of differing motivations benefit equally from the effects of acute moderate intensity exercise on such symptoms as stress and tension. A difference was found in desire to smoke, exercise reducing this more in smokers with high automatic and dependent motivation to smoke. This is possibly not unexpected as the primary feature of this motivation to smoke is dependence, and the more dependent smokers are, they appear to experience greater urges for
cigarettes during abstinence. It therefore seems that those smokers with high automatic and dependent motivation to smoke may benefit more from exercise in reducing this urge to smoke, although other withdrawal symptoms were equally reduced amongst low and high motivation groups.

It may be the case that a different motivational component may have differentially affected withdrawal and desire to smoke during and following exercise. Further research needs to be done to investigate this possibility. However, as the motivation to smoke factor used here accounted for a large proportion of variance within this sample of smokers it seemed appropriate to determine smokers by this factor rather than any other. There are potentially a large number of factors that might influence the relationship between smoking and exercise. It is beyond the scope of this study to fully examine all these variables, however this is the first research that has attempted to determine if one of these factors is significantly related to the smoking and exercise relationship. Further research utilising a similar methodology should examine other variables to ascertain how they might be related to reductions in withdrawal and desire to smoke.

7.4.2 Exercise related affect

Positive and negative affect were measured alongside withdrawal symptoms and desire to smoke in order to determine any significant relationships between affect, withdrawal symptoms and desire to smoke. The analysis of the PANAS items revealed that PA and NA changed over time. This was also done in Study Two (see chapter 5) where no significant relationships between affect and changes in withdrawal symptoms were observed. Findings from this study were consistent with findings from Study Two. No relationships were observed between positive affect and withdrawal symptoms within this study. Significant relationships were observed between negative affect and most of the withdrawal items of the MPS, in line with previous studies (potentially due to similarity of PANAS and MPS items).
The lack of a clear and consistent relationship with affect again suggests that exercise related NA and PA are not related to the causal mechanism by which exercise has been found to consistently reduce withdrawal symptoms and desire to smoke. This however was discerned via correlational analysis, and as such cause and effect can not be determined from these results. In the fist stage of this study trait affect was also recorded. Analysis revealed that trait positive/negative affect and state positive/negative affect were significantly different from each other. This suggests that when participants initially completed the PANAS they felt significantly different in terms of affect than when they were completing the experiment. This perhaps is not so surprising as at the second stage of PANAS recording participants had been abstinent from smoking from between 11-15 hours. Previous research has shown that abstinence from smoking can produce significant changes in mood (Piascecki et al, 2000). This seems also to be the case with affect, with smokers after abstinence having significantly different ratings of positive and negative affect. It has also been suggested that state and trait affect are not exactly the same constructs of affect, therefore they would not necessarily be expected to be the same (Watson et al, 1988).

7.4.3 Expectation effects

In order to ascertain if expectation of the effects of exercise on smoking related mood were related to actual changes in withdrawal, expectation of exercise effects were recorded before exercise. In order to measure expectation within this study a expectation scale was adapted in order to measure how much participants felt exercise could reduce their withdrawal symptoms, how logical they thought the use of exercise was in a smoking cessation context, and how confident they would be recommending this exercise related approach to smoking cessation to a friend (Dunmore, Clark & Ehlers, 1999). When examining scores on the credibility scale, significant relationships were observed. No significant relationship between belief in the effects of exercise on smoking withdrawal and any of the items on the MPS were found (stress, irritability etc), although at 15 and 20 minutes for desire for a cigarette and strength of desire to smoke questions of the MPS overall scores on the credibility scale were significantly related to reductions in symptoms (in all smokers). Also
significant relationships between separate question scores and items of the MPS were also observed. These results suggest that during exercise (at 15 minutes) and at the end of exercise (at 20 minutes) belief in the ability of exercise to reduce withdrawal symptoms is significantly related to how much symptoms are actually reduced at these time points. Although these results only suggest a relationship, and not that expectation causes reductions in desire to smoke, this evidence suggests this may be a possibility. However, without manipulating belief in the effects of exercise on smoking withdrawal it is impossible to confirm causality in this relationship.

As other symptoms of the MPS were not related to scores on the credibility scale then belief in exercise effects does not appear to be a major factor in all abstinence related mood. This is also borne out by the fact credibility was only related to reductions at 15 and 20 minutes, not 5 minutes after exercise (where reductions in symptoms compared to baseline were still observed). Expectation of the effects of exercise upon withdrawal may only be one of a number of variables that are related to the causal mechanisms behind this effect, and may only be relevant during exercise itself. Further investigation of this is required in order to determine how important this relationship is. Even assuming that expectation is a major cause of symptom reductions described here this does not mean that exercise is of no use to smokers. Rather it would indicate that if implementing exercise as a cessation aid that participants must believe, or be encouraged to accept, the benefits of exercise on withdrawal, which could subsequently influence how effective exercise was at reducing their desire to smoke and withdrawal symptoms during smoking abstinence.

7.4.4 Limitations

A potential limitation of this study is that the division of groups into high and low automatic and dependent motivation to smoke is based on a factor analysis that uses a measure that originally comprised of multiple components. As this is the only place this has been done it is questionable how valid this motivational factor structure is. Without validation by further testing of the questionnaire it is difficult to determine
how accurate the actual questionnaire is (and the structure proposed here is) at measuring motivation to smoke in sedentary smokers. In terms of expectation of the effects of exercise on smoking withdrawal symptoms, this was measured in this study using three questions before exercise started. The questions themselves may have alerted participants to what was being tested, and they subsequently may have changed their behaviour because of this. Future investigation into expectation and smoking withdrawal reductions following exercise should consider masking these questions in order to attempt to control for this type of confounding variable.

7.5 CONCLUSION

Results from this study indicated that 10 minutes of moderate intensity exercise was effective at reducing common smoking withdrawal symptoms and desire to smoke. These findings are in line with the findings presented in Study One and Study Two. When participants were grouped together via a measure of smoking motivation (high and low automatic and dependent motivation to smoke) no differences between the groups were found in terms of reductions in withdrawal, although there was a significant difference in desire to smoke. This suggests that motivation to smoke has no effect on withdrawal symptom reductions during and following moderate intensity exercise, but does influence reductions in desire to smoke. However, this may reflect higher initial desire to smoke in participants with high dependent motivation to smoke rather than exercise reducing desire to smoke more in this group. Exercise related affect was also measured alongside items of the withdrawal scale. Analysis revealed that expectation of the effects of exercise on smoking withdrawal symptoms was significantly related to actual reductions in desire to smoke during, and immediately after, exercise. This requires further investigation to determine is expectation is casually related to exercise related changes in symptoms.
CHAPTER 8

STUDY 4

8.1 INTRODUCTION

This chapter details the fourth, and final, study of this investigation into the effects of exercise on acute smoking withdrawal symptoms and desire to smoke. The positive effects of 10 minutes of moderate intensity exercise on acute smoking withdrawal symptoms and desire to smoke have been demonstrated in Study Two and Study Three. Shorter durations and lower intensities of exercise were investigated in Study One, with transient positive effects being reported. Study One and two provided evidence to suggest that distraction was not responsible for this effect. Study Three found evidence to suggest that automatic and dependent motivation to smoke does not have an impact on the effectiveness of physical activity in reducing withdrawal symptoms. Preliminary analysis of the findings of this study also suggested that expectation of the effects of exercise on withdrawal was related to actual reduction in desire for a cigarette and strength of desire to smoke following 10 minutes of moderate intensity exercise. This was an unexpected finding, and as such merits further investigation. If expectation is found to have a significant effect upon effectiveness of exercise at reducing withdrawal this has implications for the investigation of the mechanisms responsible for this effect. The following investigation was conducted to explore this issue in more detail.

8.1.1 Belief in the beneficial effects of exercise on mood

Expectancy of the psychological benefits of exercise might influence the acute and chronic mood changes associated with physical activity that are frequently reported in the exercise and mood literature (Salmon, 1991). These expectations might develop in several ways. For example, media reports of the positive effects exercise has on mood are a possible source of expectancy, as are personal experiences and
anecdotal reports. Exercise related mood changes may occur irrespective of expectation, however it remains to be determined as to whether the relationship between mood alteration and exercise is due to expectation or some other factor.

Within smoking and exercise research it remains a possibility that acute exercise effects on withdrawal are due to artefacts of the experiments themselves rather than exercise itself. Although studies here have ruled out a number of psychological possibilities for this effect there are other alternative factors that may be involved in mechanisms responsible for this effect. Expectation may be one of these factors. Although no research has been done investigating this relationship some researchers have investigated expectation in relation to general mood effects and exercise. For example Desharnais, Jobin, Cote, Levesque and Godin (1993) compared two groups of participants that took part in a ten-week exercise programme. One group were provided with information about the psychological benefits of exercise, and were told that exercise would have psychological benefits for them. The remaining group were not told anything regarding the potential psychological benefits of exercise. The authors found that the group that had exercise and psychological information reported significantly higher self-esteem and reported better psychological well being in the middle and at the end of the ten-week exercise programme compared to the control condition. These results suggest that participant expectation of the potential benefits of exercise are related to positive changes in mood. However there are a number of methodological issues that restrict the generalisability of these findings. For example the conclusions are only applicable to exercise over relatively long periods of time, in fit individuals. It is unclear if this same effect would occur in sedentary participants.

Pierce, Madden, Siegel, & Blumenthal (1993) for example, examined chronic changes in psychological and cognitive variables that are associated with participation in aerobic, strength and flexibility training programmes, or waiting-list control groups. Expectancy of the effects of exercise on a number of variables were measured using self-report instruments. Participants in all exercise groups reported significantly greater perceived changes in concentration, mood, energy level, and ambition compared to controls. The authors suggested that these perceived changes
reflected participant’s expectancies for improvement. Other studies however have refuted this expectancy hypothesis. Chronic exercise has been found to be associated with improved mood, but mood benefits were not associated with expectations about changes in either physical fitness or mood in some research (Berger, Owen, Motl & Parrott, 1998; Youngstedt, Dishman, Cureton, & Peacock, 1993). Similarly King, Taylor, & Haskell (1993) concluded that expectancy was not associated with changes in anxiety, depression, or stress when recorded at the start and at the end of a 12-month exercise programme.

Expectancy effects have also been explored in non-exercise contexts. For example Wilson, Lisle, Kraft, & Wetzel (1989) manipulated expectancies of participants by informing them that six cartoons were funny, when three of the images were actually neutral. Prompted participants rated the non-humorous cartoons as funnier and also exhibited more positive affect, compared to non-prompted individuals. Other researchers have also demonstrated similar findings, for example Benoit and Thomas (1993) manipulated expectancy in participants by informing them that music they were listening too contained subliminal messages designed to produce negative, positive or neutral mood states. It was found that participants who believed in subliminal messages reported more mood benefits in the positive expectancy condition than did those in the neutral and negative expectancy conditions. Again expectancy was found to be associated with changes in mood. This research not only suggests expectancy is related to changes in mood but also that it may be possible to experimentally manipulate expectation in order to influence mood.

8.1.2 Expectation effects in smoking and exercise

Results from Study Three suggested a significant relationship between expectation and the effects of exercise on desire to smoke and smoking withdrawal symptoms. Participant expectation of the effects of any experimental effect is an important potential bias in most experimental research of this type, and it remains to be examined in the context of smoking and exercise. Berger, Owen, Motl & Parks (1998) define expectancy as a belief that a certain behaviour will result in a specific outcome. In regards to the present study, it is anticipated that expectancy of exercise
effects may be significantly related to actual reductions in smoking withdrawal symptoms and desire to smoke. This belief or expectancy can be based on actual experiences, previous reactions to similar situations or based on knowledge on how others have reacted (Wilson et al 1989). According to this expectancy hypothesis a participant who has a strong belief that exercise will produce positive effects on smoking withdrawal and desire to smoke will experience these benefits more compared to someone who does not hold this belief, or holds it less strongly.

A potential problem with the way expectation was measured in Study Three was that the three exercise and smoking expectation questions that were used in this research were not masked in anyway, and therefore the questions could of alerted participants to the purpose of the experiment (which in turn could have biased their reaction to the exercise). Even if the above did not occur and expectation questions did accurately rate participant expectation of exercise effects on withdrawal, as only correlational analysis was performed it remains uncertain whether expectation actually contributed to the effects of exercise on acute smoking withdrawal symptoms. It may be that other factors may mediate this relationship. Therefore further investigation is required to determine if this is a causal relationship. This will be attempted in this experiment.

8.1.3 Manipulating expectation

This study will go beyond correlational analysis and attempt to discover whether expectation of the effects of exercise are causally related to reductions in withdrawal and desire to smoke. Some authors have suggested that judgements people make are influenced by the relative availability of information, or accessibility from memory of events related to the judgement they are about to make (Schwarz & Norbert, 2002; Williams, Watts, Macleod & Mathews, 1991). This has become known as the availability heuristic (Tversky & Kahneman, 1974). Also evidence suggests that the amount and quality of information available is related to how likely people will believe an event is or how likely it is a particular judgement will be made (Williams & Durso, 1986). Also it has been found that once a judgement is made people exhibit a degree of over-confidence in that decision. It has been found that individuals
typically express complete certainty in judgements that have low actual accuracy rates (Fischoff, Slovic, & Lichtenstein, 1977).

Due to these aspects of judgement and expectation it seems possible that by providing information to participants prior to making judgements it may be possible to influence their expectation of the effects exercise will have on smoking withdrawal. By doing so it therefore may be possible to ascertain if expectation and exercise effects on withdrawal are casually related. Investigations have found that this manipulation of expectation is possible in other research areas (for example Schwarz & Clore, 1983). Therefore it seems that when participants are forming a judgement for the first time, there will be a relationship between the judgement and recall of information related to the judgement. It may be possible to manipulate these judgements by providing certain information to participants prior to making a particular judgement. Therefore in this study information regarding the effects of exercise on smoking related mood will be supplied to participants in an attempt to influence their opinion of the effects exercise can have on withdrawal and desire to smoke. This study will measure expectation before and after judgement manipulation. This manipulation will attempt to increase and decrease expectation of the effects of exercise on smoking withdrawal symptoms. A neutral or ambiguous manipulation will also be included to investigate if having an expectancy manipulation in itself influences expectation.

8.1.4 Rationale for study 4

Participant expectation of the benefits of exercise on smoking withdrawal and desire to smoke will be investigated to determine if expectation is significantly related to the effects of moderate intensity exercise on withdrawal symptoms. This will be done via measurement of participant expectation before and after reading statements about the potential positive, negative and neutral effects of exercise on smoking withdrawal symptoms. It is felt this will provide evidence for the effect expectation has on the smoking and exercise relationship. In line with previous investigations positive and negative affect will also be measured alongside smoking withdrawal symptoms.
8.1.5 Hypotheses

- Ten minutes of moderate intensity exercise will significantly reduce acute smoking withdrawal symptoms and desire to smoke.

- Expectation of the positive effects of exercise on acute smoking withdrawal symptoms will be significantly different after reading positive and negative statements.

- Expectation will remain the same after reading a neutral statement about the effect of exercise on smoking withdrawal symptoms and desire to smoke.

- Expectation of the effects of exercise on smoking withdrawal will be related to reductions observed in withdrawal symptoms and desire to smoke following exercise.

8.2 METHOD

8.2.1 Participants and materials

Of 56 participants who expressed an interest in taking part 6 withdrew at initial screening and a further 5 did not make their appointment times. In total 45 smokers completed the exercise procedure. The recruitment criteria were the same as that described in chapter four, five, six and seven. Materials used for this stage of the experiment were also the same as those used in the previous studies (see chapter 4, section 4.2.2 for details).

8.2.2 Psychological measures

The following are descriptions of all the psychological measures that were used. Measures already implemented within previous studies will only be noted, new
measures used for the first time here will be described in more detail. For more detail for the measures already used refer back to previous chapters for detailed description of these measures:

Measures that have been used in the previous studies included the Fagerström test for nicotine dependence (Heatherton et al, 1991; revised; see appendix 1). The Seven-Day Physical Activity Recall Questionnaire (Sallis, 1978; see appendix 2) and Stages of change for smoking (Velicer et al, 1995; see appendix 18), and Stages of change for physical activity (Marcus et al, 1992; see appendix 4) were also collated. The Positive and Negative Affect Schedule was utilised again (PANAS, Watson & Clark, 1992; see appendix 11). The Borg Scale of Perceived Exertion (Borg, 1998; see appendix 5) was used to measure ratings of perceived exertion during exercise and the Mood and Physical Symptoms Questionnaire (MPS; West & Russell, 1985; see appendix 6) was used again to measure common smoking withdrawal symptoms and desire to smoke.

The Credibility scale (Dunmore, Clark & Ehlers, 1999 see appendix 24), used in Study Three to determine participant expectation of the effects of exercise on smoking withdrawal and desire to smoke was also used. The three questions of this scale, ‘How logical do you consider this approach to smoking cessation to be’? ‘How certain are you that this method will be successful in reducing your desire to smoke and withdrawal symptoms?’ and ‘with what degree of confidence would you recommend this approach to a friend who is trying to stop smoking?’ were masked amongst 6 other smoking cessation related questions. This was an attempt to try and ensure participants were not aware that expectation of the effects of exercise on withdrawal was the focus of Study Four. Three more smoking cessation techniques were substituted for the term ‘exercise’ (these were chosen with consideration with health psychology and smoking cessation experts; Mark Cropley and Chris Fife-Schaw), including hypnotherapy, mediation and use of nicotine patches, hence there were also three questions about expectancy of the effectiveness of hypnotherapy at reducing withdrawal, meditation etc.
8.2.3 Procedure

All participants were given an information sheet (see appendix 25). Participants were firstly asked the 8 questions of the Physical Activity Readiness Questionnaire (PAR-Q), a preliminary screening tool for exercise prescription and testing. This was to determine that participants were fit and healthy enough to take part in 10 minutes of moderate intensity exercise. If participants had any contra-indications then they were told they could not take part in the experiment. At this point participants CO was measured to ensure smoking status. Also a pre-abstinence resting heart rate was also taken at this point (required for exercise intensity calculations). Participants then completed the credibility scale for the first time. An appointment was then made for the actual testing session. Individuals were informed they were to completely refrain from smoking from 11 pm the night prior to the test day, and that they had to remain abstinent up to completing the test procedure. Participants were told this would be confirmed via a further CO reading at that time. Average time between initial screening and the experimental procedure was one month.

At testing participants CO was measured again. A reading of 10 or below was considered an acceptable level of CO for a smoker who had been abstinent for between 11-15 hours (Ussher et al, 2003). Resting heart rate was also measured again at this point. Participants then were randomly allocated to one of the three experimental conditions using SPSS randomisation procedure. These conditions consisted of a positive, a neutral and a negative expectation manipulation group. In the positive condition participants read a statement that indicated that exercise is beneficial in terms of withdrawal symptom reduction (see appendix 26). In the neutral condition participants read a statement that indicated some evidence pointing to the positive effect of exercise on withdrawal and a paragraph stating no effect of exercise on withdrawal symptoms had been found (see appendix 27). To control for any order effects two versions of this were used: one presenting the positive paragraph first and vice versa (all statements were piloted in a group of smokers to ensure these statements were understood by smokers). The third group read a statement that stated no effect of exercise on withdrawal had been found by research.
(see appendix 28). The experimental procedure was then identical over the three groups. The exercise procedure implemented for all participants was the same to that used in Study Two and Three (see the exercise section of 5.2.3 for a full description of this procedure). Figure 8.1 illustrates the timing of psychological measure administration. At this point participants were given a debriefing sheet (appendix 29) and paid the sum of £10.00 for their participation.

**Figure 8.1:** Study 4: timing of instrument administration

![Figure 8.1: Timing of Instrument Administration](image)

- Continual HR measurement
- PANAS
- MPS
- PANAS
- MPS
- PANAS
- MPS
- PANAS
- MPS
- PANAS
- MPS
- (enjoyment/discomfort)

8.3 RESULTS

8.3.1 Sample baseline characteristics

Baseline characteristics of the three groups are shown in table 8.1. One-way ANOVA revealed no significant differences between the three groups on baseline
characteristics. From this data it appears groups were not significantly different in terms of smoking behaviour.

### Table 8.1: Mean (SD) values for participant characteristics

<table>
<thead>
<tr>
<th></th>
<th>Positive (n = 15)</th>
<th>Ambiguous (n = 15)</th>
<th>Negative (n = 15)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>24.1 (5.5)</td>
<td>24.1 (5.5)</td>
<td>23.9 (3.9)</td>
<td>ns</td>
</tr>
<tr>
<td>BMI</td>
<td>23.5 (4.2)</td>
<td>25.5 (3.3)</td>
<td>26.1 (4.5)</td>
<td>ns</td>
</tr>
<tr>
<td>Years Smoked</td>
<td>7.75 (4.8)</td>
<td>7.7 (4.8)</td>
<td>6.7 (2.5)</td>
<td>ns</td>
</tr>
<tr>
<td>Cigarettes per day</td>
<td>14 (3.7)</td>
<td>16 (5.7)</td>
<td>13.2 (3.1)</td>
<td>ns</td>
</tr>
<tr>
<td>FTND</td>
<td>4.3 (1.8)</td>
<td>4.1 (1.9)</td>
<td>4.1 (2.1)</td>
<td>ns</td>
</tr>
<tr>
<td>ECO – pre abstinence</td>
<td>26.2 (9.1)</td>
<td>28.6 (10.9)</td>
<td>27.8 (9.1)</td>
<td>ns</td>
</tr>
<tr>
<td>ECO – during abstinence</td>
<td>5.3 (3.1)</td>
<td>5.9 (2.8)</td>
<td>4.1 (2.7)</td>
<td>ns</td>
</tr>
<tr>
<td>Resting heart rate – pre abstinence</td>
<td>74.6 (8.9)</td>
<td>74 (5.9)</td>
<td>77.7 (11.4)</td>
<td>ns</td>
</tr>
<tr>
<td>Resting heart rate – during abstinence</td>
<td>73.1 (12.6)</td>
<td>72.6 (7.7)</td>
<td>75.2 (11.5)</td>
<td>ns</td>
</tr>
<tr>
<td>Hours abstinence</td>
<td>13.2 (1.1)</td>
<td>12.5 (1.4)</td>
<td>13.2 (1.1)</td>
<td>ns</td>
</tr>
<tr>
<td>Motivation to quit (0-6)</td>
<td>1.8 (1.1)</td>
<td>1.8 (1.5)</td>
<td>2.4 (1.2)</td>
<td>ns</td>
</tr>
</tbody>
</table>

(FND = Fagerström nicotine dependence questionnaire; ECO = expired carbon monoxide; ns = non significant)

### 8.3.2 Stages of change for smoking and exercise

No participants were in the action stage (had quit smoking within the last 6 months) or maintenance stage (had quit more than 6 months ago) of smoking behaviour as this would mean they were not current smokers, violating study inclusion criteria.

Stages of change for smoking are presented in table 8.2 and stages of change for exercise are presented in table 8.3. Chi-square analysis for stages of change for exercise and smoking revealed no significant differences between the groups.

### Table 8.2: Percentage (n) scores for stages of change for smoking

<table>
<thead>
<tr>
<th>Stage of change for smoking</th>
<th>Positive (n =15)</th>
<th>Ambiguous (n=15)</th>
<th>Negative (n=15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation</td>
<td>40.1 (6)</td>
<td>26.6 (4)</td>
<td>33.3 (5)</td>
</tr>
<tr>
<td>Pre-contemplation</td>
<td>33.3 (5)</td>
<td>33.3 (5)</td>
<td>33.3 (5)</td>
</tr>
<tr>
<td>Contemplation</td>
<td>26.6 (4)</td>
<td>40.1 (6)</td>
<td>33.3 (5)</td>
</tr>
</tbody>
</table>
Table 8.3: Percentage (n) scores for stages of change for exercise

<table>
<thead>
<tr>
<th>Stage of change for exercise</th>
<th>Positive (n =15)</th>
<th>Ambiguous (n =15)</th>
<th>Negative (n =15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation</td>
<td>25.0 (4)</td>
<td>26.7(4)</td>
<td>20.0 (3)</td>
</tr>
<tr>
<td>Pre-contemplation</td>
<td>18.8 (3)</td>
<td>18.8 (3)</td>
<td>26.7 (4)</td>
</tr>
<tr>
<td>Contemplation</td>
<td>26.7 (4)</td>
<td>26.7 (4)</td>
<td>26.7 (4)</td>
</tr>
<tr>
<td>Action</td>
<td>13.3 (2)</td>
<td>13.3 (2)</td>
<td>13.3 (2)</td>
</tr>
<tr>
<td>Maintenance</td>
<td>13.3 (2)</td>
<td>13.3 (2)</td>
<td>13.3 (2)</td>
</tr>
</tbody>
</table>

8.3.3 Ratings of Perceived exertion and heart rate

Table 8.4 shows mean ratings of perceived exertion and heart rate during exercise. One-way ANOVA revealed no significant differences between groups on these variables. Average rating of exertion at 2.5 minutes in all groups corresponds to between ‘light’ and ‘somewhat hard’ on the Borg scale. Rating of exertion at 7.5 minutes in all groups corresponded to ‘hard’ on the Borg scale. A paired sample t-test revealed that resting heart rate pre-abstinence was significantly greater than resting heart rate during abstinence (just prior to testing to exercise) (t(45) = 2.181, p<0.05).

Table 8.4: Mean (SD) of ratings of perceived exertion and average heart rate during exercise

<table>
<thead>
<tr>
<th></th>
<th>Positive (n = 15)</th>
<th>Ambiguous (n = 15)</th>
<th>Negative (n = 15)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPE 2.5 mins</td>
<td>12.3 (1.9)</td>
<td>12.0 (1.5)</td>
<td>12.2 (2.5)</td>
<td>ns</td>
</tr>
<tr>
<td>RPE 7.5 mins</td>
<td>14.8 (2.3)</td>
<td>13.2 (1.6)</td>
<td>14.5 (2.8)</td>
<td>ns</td>
</tr>
<tr>
<td>HR 2.5 mins</td>
<td>127.1 (19.5)</td>
<td>119.3 (14.3)</td>
<td>116.3 (18.7)</td>
<td>ns</td>
</tr>
<tr>
<td>HR 7.5 mins</td>
<td>138.2 (18.5)</td>
<td>126.2 (18.5)</td>
<td>133.7 (15.9)</td>
<td>ns</td>
</tr>
</tbody>
</table>

8.3.4 Expectation manipulations

Figure 8.2 illustrates average scores on the credibility scale before and after group expectation manipulations. Comparing expectation scores at baseline between the groups revealed no significant differences in baseline expectation of exercise effects using one-way ANOVA. Paired sample t-tests were performed in order to determine
significant differences between scores on the credibility scale at time 1 compared to
time 2 for each group. For the positive group scores at time 1 were significantly
lower than scores at time 2 (t(14) = -3.1 p<.01). For the ambiguous group scores at
time 1 and time 2 were not significantly different from one-another, (t(14) = 0.3,
p=.704) and scores in the negative group were significantly higher at time 2
compared to time 1 (t(14) = 2.2, p< 0.05).

**Fig 8.3:** Average rating on the credibility scale at time 1 and time 2 amongst
all groups

![Bar chart showing average ratings on the credibility scale at time 1 and time 2 for different groups.]

8.3.5 **Withdrawal symptoms and desire to smoke**

The MPS items are presented together in table 8.5. Repeated measures ANOVA
showed significant main effects of time for desire to smoke, irritability, depression,
tension, restlessness, difficulty concentrating, stress and strength of desire to smoke.
No significant group by time or group main effects were found for any items of the
MPS. Mean ratings for each of the eight questions of the MPS and the desire to
smoke Tiffany question are shown in Figure 8.3 (a-h).
Table 8.5: F values, degrees of freedom, and probability results for time, group and time by group interactions

<table>
<thead>
<tr>
<th></th>
<th>Time</th>
<th>Group</th>
<th>Time * group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F value</td>
<td>df</td>
<td>P value</td>
</tr>
<tr>
<td>Q1) Desire for a cigarette</td>
<td>35.76</td>
<td>6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Q2) Irritability</td>
<td>15.838</td>
<td>6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Q3) Depression</td>
<td>6.513</td>
<td>6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Q4) Tension</td>
<td>11.903</td>
<td>6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Q5) Restlessness</td>
<td>6.539</td>
<td>6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Q6) Difficulty concentrating</td>
<td>4.153</td>
<td>6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Q7) Stress</td>
<td>10.609</td>
<td>6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Q8) Strength of desire to smoke</td>
<td>31.695</td>
<td>6</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Fig. 8.3 (a-h): Ratings of withdrawal symptoms and desire to smoke at each measurement time (high=7, low=1). a Desire to smoke. b Irritability c Depression. d Tension. e Restlessness. f Difficulty concentrating. g Stress. h Strength of desire to smoke.

Fig 8.3 a) Desire for a cigarette
Fig 8.3 e) Restlessness

Fig 8.3 f) Difficulty concentrating

Fig 8.3 g) Stress
As no significant group effects were found, paired t-tests were calculated to compare measures of smoking withdrawal symptoms between baseline ratings and each respective time period (2.5, 5, 10 and 15 minutes) for the eight questions of the MPS in the groups combined (levels of statistical significance are presented in Table 8.6). Due to the high number of post-hoc t-tests carried out (6 t-tests for each item of the MPS) a p<.008 significance level was adopted (Bonferroni t, 0.05/6 = .008). For the desire for a cigarette item and strength of desire to smoke ratings at 15, 20, 25 and 30 minutes were significantly lower compared to baseline. No significant differences were found for any condition at 5 or 10 minutes. For irritability, depression, tension, restlessness and stress significantly lower scores compared to baseline were found at 20, 25 and 30 minutes. No significant differences were observed for difficulty concentrating at any time point.
Table 8.6: The significance of comparisons of baseline ratings with each subsequent measurement time for withdrawal symptoms and desire to smoke

<table>
<thead>
<tr>
<th>Question</th>
<th>5 min Rest</th>
<th>10 min Rest</th>
<th>15 min Exercise</th>
<th>20 min Exercise</th>
<th>25 min Rest</th>
<th>30 min Rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1) Desire for a cigarette</td>
<td>ns</td>
<td>ns</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Q2) Irritability</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Q3) Depression</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Q4) Tension</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Q5) Restlessness</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Q6) Concentration</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Q7) Stress</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Q8) Strength of desire to smoke</td>
<td>ns</td>
<td>ns</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
</tbody>
</table>

(*** = significantly different from baseline p<.001; ns = not significantly different from baseline)

8.3.6 Comparisons of reductions in symptoms

The analysis described in section 8.3.5 compared symptom scores for each group to their baseline readings. With this approach it is still possible that a non-significant tendency for a difference between scores at baseline could effect the change score at each further time point. In order to assess this change scores were calculated i.e. ratings at 5 minutes minus baseline, ratings at 10 minutes minus baseline and so on (as was done in Study One, Two and Three). These change scores for each group were used in repeated measures ANOVA. When comparing this new analysis with the analysis of MPS items presented in section 8.3.5, significant main effects are identical (reported in appendix 30). As this was found to be the case it was felt further planned comparison t-tests would not be required.

8.3.7 Positive and negative affect

Positive and negative affect ratings were analysed using repeated ANOVA, the results of which are summarised in table 8.7. A significant main effect of time for PA was found but there was no significant main effects of group or group by time. Similarly for NA, there was a significant main effect of time, but main effect of
group and group by time were non-significant. (Figure 8.3 a-b illustrates mean scores on PA and NA).

Table 8.7: F values, degrees of freedom and significant levels of the repeated measure ANOVA

<table>
<thead>
<tr>
<th></th>
<th>Time</th>
<th>Group</th>
<th>Time * group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F value</td>
<td>df</td>
<td>P value</td>
</tr>
<tr>
<td>Positive affect</td>
<td>2.466</td>
<td>6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Negative affect</td>
<td>5.160</td>
<td>6</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Fig.8.3a-b): Ratings of positive and negative affect across time

Fig 8.3 a) Positive affect

![Positive affect graph]

Fig 8.3 b) Negative affect

![Negative affect graph]

Table 8.7 and 8.8 illustrates correlations between negative and positive affect and items of the MPS across time. As no group effects were observed the groups have
been combined. For positive affect only one significant relationship was observed, this was for restlessness at 25 minutes, all other times were non-significant. For negative affect, desire for a cigarette and strength of desire to smoke items no significant relationships were found. For irritability a significant relationship with NA was found at baseline, 10, 25 and 30 minutes. Scores on depression were significantly related to negative affect at all time points. Tension was significantly related to NA at all times except 20 minutes, NA was also significantly related to restlessness at 15, 20, 25 and 30 minutes, difficulty concentrating at 20, 25 and 30 minutes, and stress at baseline, 15, 20, 25 and 30 minutes.

Table 8.8: Correlations between PA and MPS items

<table>
<thead>
<tr>
<th>MPS item</th>
<th>PA t1</th>
<th>PA t2</th>
<th>PA t3</th>
<th>PA t4</th>
<th>PA t5</th>
<th>PA t6</th>
<th>PA t7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1) Desire to smoke a cigarette</td>
<td>.100</td>
<td>.112</td>
<td>.066</td>
<td>.053</td>
<td>-.257</td>
<td>-.177</td>
<td>-.201</td>
</tr>
<tr>
<td>Q2) Irritability</td>
<td>.184</td>
<td>-.062</td>
<td>-.043</td>
<td>.122</td>
<td>-.037</td>
<td>-.041</td>
<td>-.074</td>
</tr>
<tr>
<td>Q3) Depression</td>
<td>.236</td>
<td>.199</td>
<td>.232</td>
<td>.195</td>
<td>.093</td>
<td>.144</td>
<td>.006</td>
</tr>
<tr>
<td>Q4) Tension</td>
<td>.159</td>
<td>.127</td>
<td>-.061</td>
<td>.283</td>
<td>.282</td>
<td>.051</td>
<td>-.077</td>
</tr>
<tr>
<td>Q5) Restlessness</td>
<td>.124</td>
<td>.125</td>
<td>-.016</td>
<td>.175</td>
<td>.351*</td>
<td>.158</td>
<td>.090</td>
</tr>
<tr>
<td>Q6) Difficulty concentrating</td>
<td>-.004</td>
<td>-.102</td>
<td>.041</td>
<td>.012</td>
<td>.092</td>
<td>.106</td>
<td>.006</td>
</tr>
<tr>
<td>Q7) Stress</td>
<td>.106</td>
<td>.125</td>
<td>.037</td>
<td>.020</td>
<td>-.003</td>
<td>.129</td>
<td>.026</td>
</tr>
<tr>
<td>Q8) Strength of desire to smoke</td>
<td>.142</td>
<td>-.027</td>
<td>-.032</td>
<td>-.110</td>
<td>-.196</td>
<td>-.151</td>
<td>-.158</td>
</tr>
</tbody>
</table>

Table 8.9: Correlations between positive affect (NA) and MPS items

<table>
<thead>
<tr>
<th>MPS item</th>
<th>NA t1</th>
<th>NA t2</th>
<th>NA t3</th>
<th>NA t4</th>
<th>NA t5</th>
<th>NA t6</th>
<th>NA t7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1) Desire to smoke a cigarette</td>
<td>.095</td>
<td>.065</td>
<td>.181</td>
<td>.278</td>
<td>.078</td>
<td>.096</td>
<td>-.030</td>
</tr>
<tr>
<td>Q2) Irritability</td>
<td>.345*</td>
<td>.216</td>
<td>.356*</td>
<td>.216</td>
<td>.086</td>
<td>.270*</td>
<td>.508*</td>
</tr>
<tr>
<td>Q3) Depression</td>
<td>.388**</td>
<td>.405*</td>
<td>.553*</td>
<td>.600**</td>
<td>.414*</td>
<td>.507**</td>
<td>.466**</td>
</tr>
<tr>
<td>Q4) Tension</td>
<td>.314*</td>
<td>.464**</td>
<td>.374*</td>
<td>.462*</td>
<td>.253</td>
<td>.422**</td>
<td>.514*</td>
</tr>
<tr>
<td>Q5) Restlessness</td>
<td>.027</td>
<td>.188</td>
<td>.270</td>
<td>.452**</td>
<td>.303*</td>
<td>.363*</td>
<td>.374*</td>
</tr>
<tr>
<td>Q6) Difficulty concentrating</td>
<td>.255</td>
<td>.077</td>
<td>.204</td>
<td>.070</td>
<td>.336*</td>
<td>.315*</td>
<td>.390*</td>
</tr>
<tr>
<td>Q7) Stress</td>
<td>.299*</td>
<td>.284</td>
<td>.240</td>
<td>.472**</td>
<td>.466**</td>
<td>.593**</td>
<td>.441*</td>
</tr>
<tr>
<td>Q8) Strength of desire to smoke</td>
<td>.281</td>
<td>.001</td>
<td>.105</td>
<td>.188</td>
<td>.129</td>
<td>.014</td>
<td>.033</td>
</tr>
</tbody>
</table>
The findings of this study do not support the significant relationship found between reductions in symptoms and expectation reported in Study Three. In this study expectation of the effects of exercise on smoking withdrawal symptoms were successfully manipulated, both reducing and increasing expectation of exercise effects on withdrawal prior to taking part in exercise. Groups were not found to differentially report reductions in withdrawal symptomology and desire to smoke during and following exercise. Overall 10 minutes of moderate intensity exercise was found to be effective at significantly reducing acute smoking withdrawal symptoms and desire to smoke in all groups. Results indicated, in all but difficulty concentrating, withdrawal symptoms were still significantly different from baseline at 30 minutes, at the end of the experiment.

8.4.1 Expectation of exercise effects on smoking withdrawal symptoms

This study used three separate expectation manipulations in order to attempt to influence participant expectation of the effects exercise would have on their own withdrawal symptoms following acute smoking withdrawal. A methodological problem with investigating expectation is that the act of asking participants what they think will happen in the experiment could unduly influence their responses to measure during the study. In order to attempt to control for this questions about exercise effects on cigarette withdrawal were presented alongside other questions, for example including expectations of effects of nicotine patches and hypnotherapy on withdrawal symptoms. Participants were led to believe that their expectation of effects of smoking cessation methods in general, rather than just exercise, was the focus of the research rather than specifically expectation of exercise effects.

Expectation was manipulated via the theory that judgements are often made based on information available to participants the time judgements are made, and that by making certain information available directly before making judgements on exercise effects on withdrawal it was possible to manipulate expectation (Schwarz & Leigh, 2002). In the positive group, expectation of the beneficial effects of exercise on withdrawal was increased, and in the negative group expectations decreased.
Expectation scores remained unchanged in the neutral group. After statistical analysis it appeared that expectation had no effect on withdrawal and desire to smoke and as such the groups were combined for post-hoc analysis. This revealed that all symptoms and desire to smoke, bar difficulty concentrating, were significantly reduced during, and 10 minutes after exercise was completed. The fact difficulty concentrating was not effected could be a reflection of variability of withdrawal (Hughes et al, 1984) rather than a real lack of effect in this symptom. Regardless of the expectations of participants, withdrawal symptoms were reduced during and following exercise and therefore this evidence suggests that expectation as a mechanism by which exercise reduces smoking withdrawal symptoms is unlikely.

8.4.2 Perceived exertion, heart rate and affect

In line with Study Two and Study Three, exercise related changes in affect was not associated with reductions in symptoms. This suggests that exercise related changes in affect are not a mechanism by which exercise reduces smoking withdrawal. Participants perceived ratings of exertion were found to be more intense than moderate in the middle of the exercise period. Investigating RPE further should be a consideration of further research, as the consistent finding of over reporting of exercise intensity in the studies reported in this Thesis might suggest a potential barrier to smokers using exercise as a smoking cessation aid. As in Study Two and Three, heart rate was recorded before and during acute smoking abstinence. Heart rate during cessation was significantly lower than resting heart rate taken before cessation began. This is in line with previous research (West & Schneider, 1988).

8.5 CONCLUSIONS

Overall Study Four provides the first investigation into the effects of expectation and exercise induced reductions in smoking withdrawal symptoms and desire to smoke. It was found that manipulating expectations had little influence on withdrawal symptoms. Affect was found not to be significantly related to changes in withdrawal symptoms either, and appears not to be a significant factor in the relationship between exercise and smoking withdrawal symptoms.
CHAPTER 9

CONCLUSIONS AND FUTURE DIRECTIONS

9.1 INTRODUCTION

This chapter will discuss and summarise the main research of the Thesis and will draw together the main findings from this research. This will be done focusing not only on the principal findings and implications of these results but also outline both the theoretical and methodological limitations of this research. A number of possible directions for future investigations will then be discussed.

9.2 SUMMARY OF THE MAIN FINDINGS

This thesis has presented four separate, quantitative investigations, into the beneficial effects short bouts of exercise can have upon acute smoking withdrawal symptoms and desire to smoke. Some earlier research suggested that exercise may not be effective at reducing withdrawal (Hill, 1985; Pomerleau et al, 1987), although more recent research has established that exercise of short durations and moderate intensities can produce significant reductions in desire to smoke and nicotine withdrawal symptoms, during and after exercise (Ussher et al, 2001). Despite these positive findings a number of crucial issues remained unresolved: namely what durations and intensities of exercise are required for these reductions to occur, how long these effects last and also what psychological mechanisms might be responsible for this phenomenon. The aim of the studies that have been presented within this Thesis has been to further explore the relationship between exercise and smoking withdrawal.

9.2.1 Study 1

Study One was the first experimental study within which short durations of moderate and light intensity exercise were compared in terms of their effectiveness at reducing acute smoking withdrawal symptoms and desire to smoke. Previous research has
suggested that 10 minutes of moderate intensity exercise can be effective at reducing withdrawal symptoms in sedentary smokers (Ussher et al, 2001), however the mechanisms underlying this effect were not proposed. Furthermore, the effectiveness of shorter (five minute) durations of exercise, and light intensities of exercise, had previously not been investigated. The methodology of Study One involved sedentary smokers taking part in one of three conditions, either five minutes of light or moderate intensity exercise, or a passive control condition. Ratings of desire to smoke and common smoking withdrawal symptoms were measured before, during and 15 minutes after the experimental conditions.

Results indicated that light intensity exercise was only effective at reducing withdrawal during and immediately after exercise, where as moderate exercise had a longer lasting effect, with reductions in withdrawal lasting a further 5 minutes beyond that seen in the light exercise condition. These results suggested that exercise of at least moderate intensity is required to reduce withdrawal symptoms beyond exercise, and that durations of 5 minutes may only produce transient reductions in withdrawal during and immediately after exercise. A number of researchers have suggested that distraction, or an exercise related 'time-out' from stress and worry is responsible for the positive mood effects found after exercise (Berger & Motl, 2000). The light exercise condition within this study was envisaged as a distraction condition, the results therefore suggested that distraction may not be a major factor responsible for reductions in withdrawal following exercise (although as stated in chapter 4 it did not entirely rule out the possibility that distraction may still play some part in reductions of withdrawal during exercise). Another interesting finding from this study was that those smokers who were more motivated to quit and smoked more cigarettes per day, reported greater reductions in symptoms.

9.2.2 Study 2

In Study Two distraction as a mechanism responsible for the effects of exercise on withdrawal was investigated further. Longer durations of exercise were examined and exercise related changes in affect were investigated alongside withdrawal symptoms. This was done in order to investigate if general mood effects of exercise
on mood were associated with specific improvements in withdrawal symptoms. The sample of sedentary smokers recruited for Study Two were demographically the same as participants in Study One. The aims of this second study were to investigate the effects of 10 minutes of moderate intensity exercise on smoking withdrawal, against 10 minutes of cognitive distraction, and to compare the effects of exercise on positive and negative affect, with effects on smoking withdrawal symptoms.

Results indicated that 10 minutes of moderate intensity exercise was effective at reducing withdrawal symptoms and desire to smoke during and after exercise. Cognitive distraction was found not to be effective at reducing withdrawal and desire to smoke and therefore appears not to be the mechanism by which exercise reduces withdrawal (at least in the studies presented in this thesis). The pattern of the relationship between affect and withdrawal symptoms suggested that changes in positive affect due to exercise were not related to withdrawal. Negative affect was found to be related to some common withdrawal symptoms (although these were expected due to the nature of items on the affect and withdrawal measures). No significant relationship between desire for a cigarette and strength of desire to smoke, and either positive or negative affect were found.

9.2.3 Study 3

Findings from Study One suggested that certain smokers, namely those that smoked more cigarettes per day and were more motivated to quit, reported greater reductions in withdrawal following exercise than those less motivated and who smoked less cigarettes per day. The first stage of Study Three attempted to determine whether exercise was more effective at reducing withdrawal in some smokers compared to others. As the number of cigarettes smoked and motivation to quit appeared to be significantly related to reductions in withdrawal, one possible factor that might be associated with this is motivation to smoke, in particular dependence and automatic related motivation to smoke. It was predicted that dependence motivation to smoke would be a prime motivational factor, as has been found in previous research into motivational reasons for smoking (Carton et al, 2000). This first stage of this study
also incorporated brief questions concerning exercise behaviour and its relationship with smoking cessation attempts were also investigated.

Analysis of prospective smoking and exercise behaviour in smokers revealed no significant association. This suggests that smokers do not typically use exercise in a smoking cessation sense (however this may have been a result of the fact study inclusion/exclusion criteria meant smokers had to be classed as sedentary). Analysis of two motivation to smoke measures (West & Russell, 1985; West et al, 1999) revealed two consistent motivation to smoke factors amongst participants, arguably the most important being an automatic and dependent motivation to smoke. Using these motivational variables, participants were split into two groups via high and low scores on automatic and dependent motivation to smoke. Using the same exercise procedure as that used in Study Two it was found that again exercise of 10 minutes duration and of a moderate intensity was effective at reducing desire to smoke and smoking withdrawal, regardless of motivation to smoke. One unexpected finding from this research came from questions which asked participants their expectation of the effects of exercise on mood. A significant relationship was found between scores on these questions and reductions in desire to smoke during and at the end of 10 minutes of exercise, suggesting that expectation of exercise effects on withdrawal may be causally related.

9.2.4 Study 4

Due to the unexpected findings discussed above it was felt that this required investigating in more detail. The main aim of Study Four therefore was to investigate the relationship between expectation and smoking withdrawal further. Research into expectation and availability of information (Williams et al, 2004) suggests that judgements about the likelihood of events occurring is heavily influenced by information that is immediately available. Researchers have found that by providing information and manipulating the environment directly before judgements are made, researchers can influence participants’ expectations (Benoit & Thomas, 1993). In this study participant’s expectation of the effects of exercise on withdrawal and the use of exercise as a smoking cessation aid were measured at initial screening. Directly
before exercise participants were then given information which contained either, positive information, neutral information or negative information about the effects of exercise on smoking withdrawal symptoms. Expectation was then measured again. All participants then took part in 10 minutes of moderate intensity exercise, following the same procedure that was implemented in the previous studies.

Results indicated firstly that expectation was successfully manipulated in the predicted directions. When examining the effects of exercise on withdrawal and desire to smoke it was found that expectation, regardless of direction, had no significant effect on reductions in smoking withdrawal and desire to smoke. These findings suggest that expectation is not responsible for the effects exercise has upon smoking withdrawal symptoms and desire to smoke. Overall this study provided further evidence of the beneficial effects 10 minutes of moderate intensity exercise on smoking withdrawal symptoms.

9.2.5 Overall summary of research findings

Overall, the series of four studies described above have provided a number of interesting findings and new approaches to the investigation of the effects of exercise on smoking withdrawal symptoms. A number of methodological flaws in previous research (Ussher et al, 2001) meant a number of fundamental issues related to this effect remained unclear. Specifically it remained uncertain how different intensities of exercise were effective at reducing withdrawal and what durations of exercise were required to exhibit these positive effects. Due to the lack of consistency in methodologies employed to investigate this in past research, it remained impossible to conclude with any degree of confidence if exercise was effective at reducing withdrawal at all. This series of experiments in this Thesis have consistently shown the positive effects of exercise on desire to smoke and withdrawal symptoms following acute smoking withdrawal. Acute bouts of light intensity exercise appeared to produce transient reductions in symptoms, with moderate intensity exercise producing more long lasting effects. This research also attempted to determine what may be responsible for these effects. It was found that distraction, exercise-related affect, and expectations were not the main contributing factors to this relationship.
Thus the reductions in withdrawal observed could not be attributed to a psychological explanation.

It therefore appears that further investigation of this phenomenon is warranted. Although there are many other aspects of this relationship that require investigating, this series of experiments provide new evidence for the use of exercise in reducing smoking withdrawal symptoms and desire to smoke. The following sections will now describe how these findings relate to the wider picture presented by other researchers in the smoking and exercise research area, the shortcomings of this work and possible fruitful avenues of future research will be discussed.

9.3 IMPLICATIONS OF THE RESEARCH FINDINGS

9.3.1 The use of exercise as a smoking cessation aid

The main aim of exercise and smoking research, ultimately, is to determine whether exercise is effective at reducing smoking withdrawal and desire to smoke. The research studies of this thesis suggest that this is indeed the case. A further aim is to provide information about this relationship in order to enable the implementation of exercise as a smoking cessation aid. Exercise as a smoking cessation aid may be useful for a number of reasons. Current smoking cessation methods, such as nicotine replacement therapy (NRT) and behavioural support, have been found to effectively double the success rate of cessation attempts. However, this increase in success sometimes can only amount to around 15% long term smoking cessation (Silagy et al, 2001). It also may be the case that even when these methods are used successfully they may not actually be reaching a large proportion of smokers (only 5% of the total smoking population some research has suggested; Velicer et al, 1995).

Therefore it seems that new cessation aids are required as even the most widely used cessation methods may not be a lot more effective than quitting by will power alone. There are also a number of disadvantages to using some of these methods. For example from anecdotal accounts it appears that some smokers do not want to use NRT, due to an aversion to taking ‘medication’. Also some smokers may have a fear
of addiction to nicotine products in general. Even though these may be a small minority of smokers, they still deserve treatment and as such may benefit from more novel approaches to smoking cessation. Although the use of NRT products has been found to be safe in certain populations, stable coronary heart disease and lung disease patients for example (Joseph & Fu, 1996; Murray, Bailey, Daniels, Byronson, Kurnow et al, 1996), these patients are generally more hesitant in their use of such products. As such, approaches to cessation not involving nicotine replacement pharmacology may be more appropriate for these groups, although using exercise in these groups may be problematic due to health status issues.

Also using exercise as a smoking cessation aid has a number of other advantages over more conventional methods for aiding cessation attempts. For example pregnant and post-partum smokers are often unable to use NRT. Exercise may be a viable alternative for these smokers. Although NRT is now licensed for pregnant smokers who cannot stop without it, there is no evidence for the effectiveness of NRT in this population and only a small minority of pregnant smokers are likely to be interested in using it (Ussher & West, 2003). However, evidence from surveys suggests that pregnant smokers are motivated towards using exercise as an aid to smoking cessation (Ussher et al, 2003), therefore this group of smokers may benefit from the use of exercise as an alternative to more conventional smoking cessation aids. Similarly another specific sub-group of smokers are cardiac rehab patients, who may benefit from the use of exercise as they are expected to both cease smoking and be physically active (Mickley & Saunamaki, 2003; Reid, Pipe, Higginson, Johnson, D'Angelo et al, 2003), implementing the two together in this group may prove useful, although again health status of patients will impact upon whether exercise in the groups is possible.

Other evidence suggests that smokers, specifically female smokers, often state that the weight gain commonly associated with nicotine cessation is a significant barrier for them giving up (Klesges & Klesges, 1988; Rigotti, 1999). Weight gain has been found to be associated with smoking cessation (Klesges, Meyers, Klesges & LaVasque, 1989), although this may not necessarily be permanent. King, Matachin, Marcus, Bock and Tripolone (2000) provide evidence showing that female smokers
may be more dissatisfied with their bodies compared to female non-smokers, and that this impacts upon their cessation attempts in a negative way. Pomerleau, Namenek, Brouwer and Jones (2000) investigated weight concern in women smokers. Pomerleau and colleagues reported that this was a major concern for these smokers, therefore cessation methods that attempt to counter this weight gain might be of particular interest to female smokers attempting to quit. Exercise could be an ideal solution to cessation for this group, as it not only reduces withdrawal symptoms but if done on a regular basis could counter the weight gain that has been commonly associated with smoking cessation attempts.

9.3.2 Exercise intensity calculations, perceived exertion and heart rate

An issue of crucial importance to the smoking and exercise relationship is how intensity of exercise is calculated. A criticism of previous smoking and exercise research is that intensity calculations are often not made explicit. In some instances exercise intensity is not formally calculated, rather participants are told to exercise at a moderate intensity (Marcus et al, 2003) and this is verified via self-report measures only. With this approach it is difficult to determine what intensities participants are actually exercising at. A potential problem with calculating exercise intensity in smokers is that smokers heart rate while they are smoking may be significantly different than their heart rate during cessation (Bernards et al, 2003; Perkins et al, 1989). Basing intensity calculation on heart rate whilst smokers are still smoking may create inaccuracy in intensity calculation. As it is the aim of smoking cessation in general to keep people abstinent in the long term then it is suggested here that it is this lower heart rate, during abstinence that should be used during intensity calculations. In Study Two, Three and Four heart rate before acute abstinence was found to be significantly higher than resting heart rate after 12-15 hours of smoking abstinence. Therefore it was this pre-abstinence measure of resting heart rate that was used for intensity calculation. This was felt to provide a more accurate moderate level of intensity than that used in previous experiments.

Another interesting issue that was investigated was what intensities of exercise smokers felt they were exercising within. It was found consistently within this
research that the majority of smokers overrated the intensity of the exercise, at least once, during the exercise conditions. As smokers self-reported to be sedentary as part of all studies inclusion criteria, this overestimation of intensity is perhaps not so surprising, as being sedentary implies a lack of experience of exercise. This finding begs the question whether moderate intensity is actually required for exercise to have positive effects on withdrawal symptoms, as smokers may only have to feel they are exercising at a moderate intensity in order to benefit from exercise in terms of withdrawal symptom reduction.

A recent study by Katomeri, Taylor and Ussher (2003) investigated the effects of a one-mile, self-paced, treadmill walk on desire to smoke compared to resting control. Participants, who had been abstinent from smoking from between 12-15 hours, were randomly assigned to two counter balanced 15-minute conditions consisting of one mile of brisk walking at a preferred intensity and a passive, resting control condition. These effectively meant participants completed both the control and exercise condition in a repeated measures design. Throughout these conditions perceived exertion was measured, as were withdrawal symptoms and desire to smoke. Results indicated that walking significantly reduced desire to smoke and enhanced affect amongst nicotine deprived smokers. What is more, this study provides evidence that self-paced exercise was sufficient to reduce withdrawal. These findings might suggest that intensity may prove irrelevant as long as the smoker is exercising at a preferred intensity. This begs the question whether it is something intrinsic in taking part in exercise that results in this effect or actually due to specific intensities of exercise for specific durations? In this case the majority of smokers did actually exercise in a moderate intensity range though. It might also be argued that exercise reduces desire to smoke because smokers are so out of breath after exercise they could not physically smoke. This may have been the case for some smokers in the research of this Thesis, however exercise was effective in reducing desire to smoke at least 5 minutes after exercise, and in some cases longer, well after participants had recovered from the exercise itself (this was not actually tested in this research so this remains only speculation at this point).
9.3.4 Sedentary smokers

Another methodological shortfall of the majority of current smoking and exercise research is that exercise programmes investigated are often of long durations and of higher than moderate intensities (for example Bock et al, 1999). As such they may not be realistic exercise programmes for smokers to actually do. Research has shown that the majority of smokers are sedentary (Ford et al, 2000; Kimm et al, 2002) and therefore are unlikely to be able, or inclined, to engage in frequent bouts of vigorous intensity exercise. The advantage of the exercise interventions employed in this research is that they are short, of moderate intensity and yet are still effective at reducing withdrawal. These short bouts of exercise seem to present a viable option for sedentary smokers to use exercise as a cessation aid. It does not seem particularly plausible that smokers will be able to do much more than this, and as such it seems that exercise research should focus on exercise of these durations and intensities. A problem with this use of exercise for cessation purposes is that research here suggests exercise was not effective for longer than 10 minutes in reducing symptoms. If this is the case then in order to be effective, smokers would have to use exercise at exactly the time withdrawal symptoms and desire to smoke were at their strongest, or they would have to exercise continuously to benefit. It may hence be the case that exercise will have to be used with careful planning by smoking cessation professionals, and alongside other cessation aids, so smokers do not only have exercise as an option at reducing withdrawal.

Research would benefit from explicitly testing only sedentary smokers, as done elsewhere (see Marcus et al, 1999; Ussher et al, 2001), as it is envisaged this provides a more realistic investigation of exercise as a smoking cessation aid (as the majority of smokers are sedentary). Overall this research suggests that smokers could potentially benefit from using these types of exercise interventions in order to reduce adverse smoking withdrawal symptoms. Attempting to use greater intensities for longer durations may prove useful as well, although it would seem inopportune to do so without fully exploring the potential use of short bouts of moderate intensity exercise in this population.
9.3.5 Mechanisms

A key aim of the research presented here was to explore a number of potential causal mechanisms that might be responsible for the effects of exercise on smoking withdrawal. Previous research in the smoking and exercise area has suggested that mechanisms for the effects of exercise on withdrawal need investigating (as Ussher et al, 2001 suggests), however so far it appears to be the case that this has not been undertaken. Indeed, the vast majority of smoking and exercise research does not even postulate what may be responsible for the effects they report. There are a number of possible physiological explanations for the general positive mood effects associated with exercise, for example the serotonin and endorphin hypothesis (Carr et al 1981; Jensen et al, 1995). However, these have not been investigated in relation to smoking withdrawal related mood and exercise. These still remain possible mechanisms by which exercise asserts its effects on withdrawal, although as mechanisms remain uninvestigated in this research area there are a number of other non-physiological mechanisms that need investigating also.

It seems logical to first examine (and to rule out) psychological explanations for this effect. The studies presented within this thesis attempt to address this by investigating a number of psychological mechanisms responsible: namely distraction, changes in affect due to exercise and expectation. In all three cases research presented in this thesis suggests that none are causally related to the effects of exercise on smoking withdrawal and desire to smoke. This is the first experimental attempt to determine what is responsible for the effects exercise has on smoking withdrawal and as such provides both theoretical and practical information. From a theoretical viewpoint it seems feasible that as these mechanisms do not appear responsible for the effect then a possible physiological mechanism becomes a more feasible possibility. Although not exhaustive, it is felt, these findings cover a number of the most obvious, and important, non-physiological alternative mechanisms. On a practical note these findings may provide information to those who will actually implement exercise in smoking cessation contexts. By having knowledge of this it seems feasible that health professionals will be better able to deliver, and ultimately
‘sell’ exercise as a smoking cessation aid to smokers. Which will hopefully in turn have a positive effect upon long-term smoking cessation rates.

9.4 LIMITATIONS

9.4.1 Theoretical limitations

One of the main limitations of using exercise as a smoking cessation aid, despite all studies providing evidence to suggest exercise can have benefits for smokers in terms of symptom reduction, it remains a problem that expecting smokers to actually do exercise may be unrealistic. Changing from being a long-term smoker to a non-smoker has been found in numerous studies to be difficult (West et al, 1999, West et al, 2001). Similarly is has also been found that adhering to exercise regimes in sedentary people can be equally problematic (Wankle, Yardley & Graham, 1985). Hence a major problem with using exercise as a cessation aid is the fact sedentary smokers will have to try and change two major lifestyle behaviours at the same time, going from being a smoker to a non-smoker and being sedentary to being physically active. Research has shown that this can be problematic and is more likely to result in failure comparing to only changing one of these behaviours (Bourdeaux, Francis, Taylor, Scarinci & Brantley, 2003). However, as durations of exercise of only 10 minutes have been found to be effective at reducing withdrawal, this may not be as difficult for smokes than for longer exercise durations. So far within the exercise and smoking research area qualitative methodologies have been overlooked in favour of quantitative approaches. Qualitative research might provide a number of valuable insights into what smokers actually think about exercise and its relationship to smoking, in particular in relation to the above limitation of exercise use in this context.

It remains unclear from this research whether longer durations of moderate intensity exercise would continue to be effective at significantly reducing withdrawal. It is also unclear if exercise will work outside a laboratory setting. Some evidence suggests that it might (Thayer et al, 1993) although this evidence alone is not enough to equivocally state this would be effective. It is also unclear if decreased withdrawal
and desire to smoke would actually produce reduced cigarette consumption, although this may be assumed from this research it was not empirically investigated. Also although light and moderate intensities of exercise were investigated within this Thesis it remains unclear exactly how different intensities exactly effect symptom reduction. The measures of intensity used within these experiments, although widely used, are relatively simple. There are a plethora of other techniques, (such as VO$_{2\max}$ and maximum aerobic capacity markers), some involving physiological measurements, that can provide more accurate measures of intensity. By implementing multiple measurement techniques, with varying and precise increments of exercise intensity, it may be possible to discern the exact effects of differing intensities on symptom reduction in a more thorough way.

Participants within this Thesis were recruited for the purposes of each individual study and were given financial re-numeration for taking part. None of the individuals stated that they were actually stopping smoking permanently. Due to this the effect of exercise on smokers wishing to give up permanently may be different to the effects seen in this sample. Tate, Schmintz and Stanton (1993) state that temporary withdrawal symptoms may be psychologically different from withdrawal that is part of a cessation attempt, hence it may not be appropriate to generalize findings from this study to naturalistic withdrawal attempts. The sample of participants used in this study were predominantly drawn from a university student population, and as such were quite young and had been smoking on average only about 4 years.

Research by Ussher et al, (2001), using the same exercise methodology employed here, used a sample that was older and generally had been smoking for significantly longer. Although similar effects were reported in Ussher et al’s study, reductions in smoking withdrawal symptoms appeared to last longer, beyond the exercise condition. This may be a shortcoming of the research presented here as findings may only be applicable to the population of smokers actually tested, that is relatively young, university educated smokers who had been smoking for a relatively short time. Also as stationary cycling was used in the exercise conditions of all experimental studies, it remains unclear if other modes of exercise, such as walking or swimming for example, would have the same effects on symptoms and desire to
smoke. Research conducted here suggest that exercise is effective at reducing symptoms associated with the first 12-15 hours of cessation, however this provides no information on how exercise will affect symptoms in say the third week of cessation, or even beyond the first six months. Smoking cessation advisors and others involved in actually implementing smoking cessation measures, need to be aware of these issues if exercise is ever to be implemented in a smoking cessation context.

9.4.2 Methodological limitations

There are also a number of issues inherent in the methodology employed in this research that may limit the findings. Firstly, despite the fact withdrawal and desire to smoke were measured using a measure of withdrawal that has been used in previous research (West & Russell, 1985), it may be argued that the subjective nature of the measures might bring into question the validity of the research findings. There is little agreement amongst researchers in this area what constitutes smoking withdrawal and it remains an issue whether some symptoms should be classed as withdrawal symptoms at all (anxiety for example; West & Hajek, 1997). However, it remains to be determined how withdrawal could be measured reliably without some form of self-report approach. Along the same lines, some question has been made upon the reliability of self report measures of physical activity. In particular it has been suggested that the Seven Day Physical Activity Recall Questionnaire (Blair et al, 1984) might not provide accurate estimates of current activity level (Scott & Eves, 2003). If this is the case then this would indicate participants ratings of activity could be inaccurate, and hence bring into question whether the sample used was actually sedentary.

Another potentially important methodological issue is that measures of withdrawal and affect for example, had to be taken repeatedly throughout a short time period in each study. This consistent reporting may have adversely affected the validity of the measure by effecting participants rating of withdrawal, possibly due to fatigue or cueing participants to the aims of the experiment. However, until single measures of withdrawal are made accessible it remains unclear how this could be controlled when
investigating such short durations of exercise, whilst at the same time attempting to measure withdrawal and desire to smoke in a valid and reliable way. Although dependence measures, (Fagerström et al, 1978), were used to determine levels of addiction amongst smokers this may not be a completely accurate view of level of addiction to smoking. It is very difficult to control or determine the amount of nicotine any one smoker absorbs whilst smoking (Peterken, Cook & Stokes, 2002) and it may be just as difficult to extrapolate from self-report measures alone how addicted a particular smoker actually is. The fact that the consistency of nicotine intake and smoking patterns have been found to be different amongst smokers, it may be difficult to truly determine individual intake of nicotine, and therefore levels of addiction in smokers (Sutton, Russell, Iyer, Feyerabend & Saloojee, 1982).

The reliability of other measures used in this series of studies is also potentially a limitation of this research. Study Three relied on an analysis of established motivation to smoke measures to determine different motivations to smoke. Due to restrictions of sample size it was not possible to fully explore motivations to smoke presented by this analysis. Evidence presented in Study Three did not support the idea that different types of smokers would benefit more from exercise than others' however due to sample restrictions not all motivations to smoke were explored. It could have been that further analysis of different factors would have produced differences in withdrawal. In Study Four expectations were also measured using a measure adapted specifically for this study, therefore no reliability or validity data exists for this measure.

9.5 FUTURE DIRECTIONS

9.5.1 Intensity, type and duration

As has been touched upon above, a limitation as well as strength of this research was that it implemented only one type of exercise, for durations of only between 5-10 minutes and of moderate intensities. Therefore the findings of the research are limited to these exercise parameters. Future research, implementing a similar methodology to that used within the work of this Thesis, into different modalities of
exercise, different lengths and a more in-depth investigation of intensity would provide further valuable information about this relationship. From such research the limitations of exercise as a smoking cessation aid would be uncovered, as well as the optimum type and duration of exercise required to have efficacious effects on smoking withdrawal and desire to smoke. A criticism of earlier work into exercise and smoking was that the variety of methodologies employed made it difficult to draw a consistent picture of the effects of exercise on smoking withdrawal symptoms. By utilising and adapting a methodology already employed successfully in this area (Ussher et al, 2001) the studies of this Thesis present a methodologically consistent investigation into exercise and smoking. Future research examining the acute effects of exercise on smoking withdrawal symptoms should attempt to continue this trend by using similar methodologies, which will make assimilation of findings easier and more fruitful.

9.5.2 Physiological mechanisms

One avenue of research that merits further attention is the investigation of the mechanisms responsible for this effect. The findings of this thesis suggests that a number of psychological factors are not significantly related to the effects of exercise on smoking withdrawal symptoms. There are however also a number of possible physiological mechanisms that might be responsible for these effects (serotonin, norepinephrine, endorphine etc). Research investigating how exercise effects these substances in relation to smoking withdrawal would be most useful. These investigations would undoubtedly be difficult and complex, yet they could provide the possibility not only to determine the main physiological variables in this effect, but also to increase physiological knowledge about smoking addiction and withdrawal in particular.

Another interesting possibility of future research was actually originally planned to be investigated as the final study in this thesis but due to equipment problems this became impractical. This investigation would have focused on the effect exercise has on brain activity and the possibility that these effects are similar to the neurological effects of smoking. Studies have been conducted investigating the effects exercise
has upon Electroencephalographic (EEG) activity. For example Lardon and Polich (1996) compared baseline EEG's of very physically active and less physically active individuals. They found that those fitter participants had increased resting mean band frequency compared to less physically active participants in alpha, delta and theta band widths. Other studies investigating exercise and EEG activity have also shown that exercise can change EEG activity in similar ways. Physical exercise has been found to reverse EEG changes in depressed rats (as defined by changes in behaviour) for example (Sarbadhikari, Dey & Ray, 1995). Wiese, Singh and Yeudall (1983) recorded brain activity before, during and after 40 minutes of exercise (25 minutes at 40% maximal oxygen uptake (VO$_{2\text{max}}$), 15 minutes at 60% of VO$_{2\text{max}}$) and in a non-exercise control group. Wiese et al found that the exercise group showed a significant increase in alpha power during the post-exercise period compared to controls.

Evidence looking at the same effects, but in relation to smoking have found similar results. Knott (2001) reviewed the literature on smoking and EEG effects and concluded smoking a preferred brand cigarette resulted in a stimulant-like EEG profile. This included reduction in amplitude/power in slow wave delta and theta waves and increases in alpha and beta waves. Smoking deprivation was found to result in opposite effects, namely EEG deactivation indicated by increases in slow wave amplitude/power and decreases in dominant frequency. There is a large amount of research which has investigated the effects of smoking on brain activity, specifically the effects of smoking on EEG activity has found similar results (Herning, Jones & Bachman, 1983).

Comparing the findings of these bodies of work might suggest that exercise may have a similar effect on brain activity as smoking a preferred brand cigarette, which may reflect a mechanism by which exercise reduces withdrawal. Future research investigating this would provide an interesting insight into this possibility. If such future research did find similarities then investigations using other types of brain imaging apparatus, such as fMRI scans, might further refine knowledge about this relationship, by comparing neural activity before and after exercising. It might also provide valuable information about addiction in general.
9.5.3 Exercise interventions and other smoking cessation aids

Tailoring interventions to health behaviours has been found to be the most effective means of changing behaviour in smokers (Velicer Fava, Prochaska, Abrahms, Emmons et al, 1995) and for increasing exercise (Marcus, Bock, Pinto, Forsyth, Roberts et al, 1998). Hence tailoring exercise to particular smokers may be a useful way to use exercise in a cessation context. A future investigation could attempt to find the best approach to implement exercise in this way, hence ensuring that those smokers who are most able, and who are most motivated, use exercise for this purpose.

It remains to be determined whether exercise will be effective as a smoking cessation on its own or in conjunction with other smoking cessation methods. It has been found that combinations of cessation aids, rather than the sole use of one technique, can be most effective at aiding cessation attempts (Chatkin, de Abreu, Haggstram, Wagner & Fritscher, 2004). As has also been found to be the case with other behavioural support and NRT (Silagy et al, 2001) exercise might be best used alongside other smoking cessation aids. Research has implemented exercise counselling alongside smoking cessation support in groups and with it NRT use also (Ussher et al, 2004) and some positive effects were reported. However, this was not an investigation into actual exercise, moreover its aim was to increase exercise via support rather then implementing actual supervised exercise sessions. Further research should aim to investigate the effects of exercise on its own, and compare its use in conjunction with other cessation approaches, such as NRT, in order to determine if exercise has an additive or a synergistic effect when paired with these other techniques.

9.5.4 Exercise and addiction

Another interesting possibility for future research is to investigate what effect exercise might have on other addictions. Research suggests that exercise might be an effective strategy to use in alleviating the symptoms of other disorders, such as psychological problems like depression (Sime, 1987) and anxiety (Stien et al, 1992). This begs the question whether exercise could be effective at reducing the
withdrawal symptoms of other addiction disorders as well. Ussher, Sampuran, Doshi, West and Drummond (2004) examined whether acute bouts of moderate intensity exercise reduced urges to drink and mood disturbances in alcohol dependent participants. Ussher et al found that exercise appeared to be effective at reducing alcohol urges during exercise but not after it and mood disturbance did not appear to be effected by these amounts of exercise at any time point. Although these results do not show such an emphatic change in urge to drink as has been demonstrated with urge to smoke the fact reductions during exercise were seen suggests that exercise might at least be partly effective in this population.

This was the only investigation of the acute effects of exercise on alcohol urges and as such further investigation into this is required. If further investigation reveals there is an efficacious effect of exercise at reducing alcohol urges then this might indicate that exercise is effective in combating addiction in general. As such investigations into other addictions, such as heroin abuse for example, might then be possible. Overall acute bouts of moderate intensity exercise provide a novel approach, and potential treatment to the management of addictions, and on its own or alongside other cessation interventions, exercise could provide a useful additional way to treat and maintain abstinence.

9.6 CONCLUSIONS

In summary, this Thesis investigated the effects of exercise on smoking withdrawal symptoms and desire to smoke and examined a number of crucial issues related to this relationship. Some of the methodological shortcomings of previous research (as stated by Ussher et al, 2000) were addressed in this series of four experiments and it was found, overall, that short bouts of moderate intensity exercise were effective at reducing acute smoking withdrawal symptoms in sedentary smokers. The research presented here suggests that distraction, exercise related affect and expectation of the effects of exercise on psychological wellbeing (and in particular effects on withdrawal symptomology) were not responsible for the positive effect exercise has on smoking withdrawal. Thus a purely psychological explanation was not found.
REFERENCES


Appendix 1

Physical Activity Readiness Questionnaire

Participant No. ……

Participants Address:

Now I need to confirm you are eligible for the study:

1) How old are you?

2) How many cigarettes do you smoke on average each day?

3) How many years have you been smoking?

4) Will you be able to attend an appointment in the next 2 weeks?

5) Can you read and write in English?

6) Are you currently receiving treatment for a mental health problem?

7) Are you currently pregnant or planning a pregnancy?

8) Do you currently have a heart condition or any other condition that prevents you from exercising?

Finally I want to get an idea how much exercise you do. How many times in the last 7 days did you exercise for 30mins or more. I’m interested in anything that gets you breathing slightly harder than normal. Include routine activities such as brisk walking as well as formal exercise and include anything you did for at least 5 minutes.
**Medical Questionnaire**

I just need to ask you a few questions about your general health.

Could you please answer YES or NO to the following questions.

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by the doctor?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Do you feel pain in your chest when you do physical activity?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. In the last month have you had chest pain at any other time?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Do you ever loose your balance because of dizziness, or do you ever faint?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Do you have any bone or joint problems that become aggravated when you are more active?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Do you suffer from asthma?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Is your doctor currently prescribing you any medication for high blood pressure?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Do you know of any reason why you should not do exercise?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Now I would like to make an appointment with you.

You will receive details of how to get to the University for testing. Please continue to smoke as normal, you will be advised to stop smoking nearer the appointment date.

**Appointment:**

**Not take part ......reason why**
Appendix 2

Fagerström test for nicotine dependence

How many cigarettes per day do you usually smoke? 

(Write the number in the box and circle one response)

(F1) 10 or less 0
      11 to 19 1
      20 to 30 2
      31 or more 3

(F2) How soon after you wake up do you smoke your first cigarette? (circle one response)

Within 5 minutes 3
6-30 minutes 2
31 or more 1

(F3) Do you find it difficult to stop smoking in no-smoking areas? (circle one response)

No 0
Yes 1

(F4) Which cigarette would you most hate to give up? (circle one response)

The first in the morning 1
Another 0

(F5) Do you smoke more frequently in the first hours after waking than during the rest of the day? (circle one response)

No 0
Yes 1

(F6) Do you smoke even if you are so ill that you are in bed most of the day? (circle one response)

No 0
Yes 1

Expired Carbon Monoxide .............

Resting heart rate......................

Has the participant abstained from smoking as required?...

YES/NO

What is your usual brand of cigarette/nicotine product?.....

At what time did you have your last cigarette?: .......

Hours since last cigarette: ....... 

Occupation .......
Appendix 3

Seven Day Physical Activity Recall

Label the days on the recall table (day 1 is yesterday).

Describe the type of activity which you are interested in.
Explain that you are interested in any work, household or leisure activities that are at a level of intensity which makes them breathe slightly harder than normal, makes them aware that their heart is beating faster and last for at least 5 minutes.

Introduce seven day recall. Explain that you'd like to know about any of this type of physical activity which they have done in the last week, starting with yesterday and working backward.

Ask about activities. For the morning, afternoon and evening each day in the last week ask the patient to recall any activity episodes. Record the type of activity using the activity codes and total duration each day in minutes. Round times to the nearest 5 minutes. For each day begin by asking “What did you do and where did you go on that morning?” Ask participant if last week was a typical week for physical activity. If it was not, for example, because they were ill or away from home, ask them to think about the previous week.

Distinguish between moderate, hard and very hard activities
For each activity you record ask the patient if the intensity was about the same as a brisk walk, the same as a jog or run or somewhere in between a jog/run and a brisk walk. For those activities judged to be equivalent to a jog or run label them as very hard (VH), for those in between a jog/run and a brisk walk label them as hard (H).

<table>
<thead>
<tr>
<th>DAY</th>
<th>MORNING</th>
<th>AFTERNOON</th>
<th>EVENING</th>
<th>Minutes of Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (yesterday)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
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<td></td>
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<td>3</td>
<td></td>
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</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Record the number of hours of moderate activity: \( \text{hrs} = \frac{60 \text{ mins}}{1} \)

Ask the patient if they have done any hard activity (i.e. that which feels harder than how they feel when they are on a brisk walk) and enter day, activity type, duration and pulse in box:

Record number of minutes of 'hard' activity:

Record the numbers of hours of hard activity:

Ask the patient if they have done any 'very hard' activity, (i.e. that which feels similar to how they feel when they are jogging or running) and enter day, activity type, duration and pulse in box:

Record minutes of 'Very hard' activity:

Record the number of hours of very hard activity:

Record the numbers of days with 30 minutes + of hard or very hard activity:

Record number of days with 30 minutes + of moderate, hard or very hard activity:

Record main mode of physical activity (circle one item only):

<table>
<thead>
<tr>
<th></th>
<th>Exh</th>
<th>Exf</th>
<th>H</th>
<th>Sw</th>
<th>DIY</th>
<th>Cyc</th>
<th>G</th>
<th>D</th>
<th>Spi</th>
<th>Spt</th>
<th>Occ</th>
<th>O</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
</tr>
</tbody>
</table>

Compare seven day recall to activity over previous 3 months
Ask the participant "How much physical activity did you do last week compared to the previous 3 months?" (circle one number only)

<table>
<thead>
<tr>
<th>Much less</th>
<th>Less</th>
<th>About the same</th>
<th>More</th>
<th>Much more</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Appendix 4

Stages of change for physical activity

By circling one number only, please state which of the following statements most accurately describe how you feel at present about being physically active.
I am only interested in exercise which makes you breath even slightly more than normal and feels at least as hard as when having a brisk walk.

<table>
<thead>
<tr>
<th></th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I do not exercise regularly and I do not intend to start in the next 6 months</td>
</tr>
<tr>
<td>2</td>
<td>I do not exercise regularly but I intend to start in the next 6 months</td>
</tr>
<tr>
<td>3</td>
<td>I do some exercise but not regularly</td>
</tr>
<tr>
<td>4</td>
<td>I exercise regularly but I have been doing so for less than 6 months</td>
</tr>
<tr>
<td>5</td>
<td>I have exercised regularly for 6 months or longer.</td>
</tr>
<tr>
<td>6</td>
<td>I used to exercise regularly but I have not done so for at least 12 months</td>
</tr>
</tbody>
</table>

Please answer the following question.
(Circle one response for each question)

**Do you want to stop smoking for good?**

<table>
<thead>
<tr>
<th></th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No</td>
</tr>
<tr>
<td>1</td>
<td>Maybe</td>
</tr>
<tr>
<td>2</td>
<td>Yes, very much</td>
</tr>
</tbody>
</table>

**Do you intend to make a serious attempt to stop smoking in the next 3 months?**

<table>
<thead>
<tr>
<th></th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No</td>
</tr>
<tr>
<td>1</td>
<td>Maybe</td>
</tr>
<tr>
<td>2</td>
<td>Yes, very much</td>
</tr>
</tbody>
</table>
Appendix 5

Borg scale of perceived exertion

While exercising I want you to rate your perception of exertion, i.e. how heavy and strenuous the exercise feels to you. The perception of exertion depends mainly on the strain and fatigue on your muscles and on your feeling of breathlessness or aches in the chest.

Look at this rating scale; I want you to use this scale from 6 to 20, where 6 means “no exertion at all” and 20 means ‘maximal exertion’.

Try to appraise your feeling of exertion as honestly as possible, without thinking what the actual physical load is. Don’t underestimate it, but don’t overestimate it either. It’s your own feeling of effort and exertion that’s important, not how it compares to other people’s. What other people think is not important either. Look at the scale and the expressions and give a number.

Any questions?

(1) HR: □

<table>
<thead>
<tr>
<th>No Exertion</th>
<th>Very light</th>
<th>Light</th>
<th>Somewhat Hard</th>
<th>Hard (Heavy)</th>
<th>Extremely Hard</th>
<th>Maximum Exertion</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
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<tr>
<td>20</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(2) HR: □

<table>
<thead>
<tr>
<th>No Exertion</th>
<th>Very light</th>
<th>Light</th>
<th>Somewhat Hard</th>
<th>Hard (Heavy)</th>
<th>Extremely Hard</th>
<th>Maximum Exertion</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
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<td>19</td>
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<tr>
<td>20</td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>
Appendix 6

Mood and physical symptoms scale – study 1

1. Would you say you have a desire for a cigarette right now?

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Neutral</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Session</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5 mins: into</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>session</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 mins: end</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>session</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 mins: after</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>session</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 mins: after</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>session</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. How irritable do you feel right now?

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>Somewhat</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Session</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5 mins: into</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
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<tr>
<td>session</td>
<td></td>
<td></td>
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<tr>
<td>5 mins: end</td>
<td>1 2 3 4 5 6 7</td>
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<td>session</td>
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<td></td>
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<tr>
<td>5 mins: after</td>
<td>1 2 3 4 5 6 7</td>
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<td>session</td>
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<td></td>
</tr>
<tr>
<td>10 mins: after</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>session</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. How depressed do you feel right now?

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Session</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>2.5 mins: into session</td>
<td>1</td>
<td>2</td>
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<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>5 mins: end session</td>
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<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
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<tr>
<td>5 mins: after session</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>10 mins: after session</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

4. How tense do you feel right now?

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Session</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>2.5 mins: into session</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>5 mins: end session</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>5 mins: after session</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>10 mins: after session</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>
5. How restless do you feel right now?

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>Somewhat</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Session</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5 mins: into session</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 mins: end session</td>
<td>1 2 3 4 5 6 7</td>
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</tr>
<tr>
<td>5 mins: after session</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 mins: after session</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Do you find it difficult to concentrate right now?

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>Somewhat</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Session</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5 mins: into session</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 mins: end session</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 mins: after session</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 mins: after session</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
7. How stressed do you feel right now?

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Not at all</th>
<th>Somewhat</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Session</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5 mins: into session</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 mins: end session</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 mins: after session</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 mins: after session</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. How strong is your desire to smoke right now?

<table>
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<th>Extremely</th>
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<tr>
<td>Before Session</td>
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<tr>
<td>2.5 mins: into session</td>
<td>1 2 3 4 5 6 7</td>
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<td>5 mins: end session</td>
<td>1 2 3 4 5 6 7</td>
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<td>5 mins: after session</td>
<td>1 2 3 4 5 6 7</td>
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<tr>
<td>10 mins: after session</td>
<td>1 2 3 4 5 6 7</td>
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<td></td>
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</table>
The aim of the study is to investigate the effect of a short bout of moderate exercise on nicotine withdrawal. You will be asked to attend the psychology laboratory at Surrey University. You will be asked not to smoke even a single puff of a cigarette from 12pm the night prior to the visit. The visit will take approximately 30 minutes. At the start of the visit you will be asked to blow into a machine that measures your exposure to cigarette smoke. **The aim will be to confirm you have not smoked.** You will be asked to fill out a number of questionnaires, one of which will ask you to rate your desire for a cigarette and your mood. You will then be allocated to one of three conditions. **Either:**

1) **You will be asked to sit quietly for approximately 15 minutes** and to complete a questionnaire every few minutes.

2) **You will be asked to sit on an exercise bike and to pedal very slowly for about 7 minutes.** In order to monitor your heart rate you will need to wear a chest-band. Every few minutes you will be asked to complete a questionnaire.

3) **You will be asked to sit on an exercise bike and to pedal at a moderate speed for about 7 minutes.** In order to monitor your heart rate you will need to wear a chest band. Every few minutes you will be asked to complete a questionnaire.

You will be free to withdraw from this study at any time. Do you have any questions?
If you have any queries please phone James Daniel on 01483 87 ext 3971/07786372815 or e-mail J.Daniel@surrey.ac.uk
I would like to take this opportunity to thank you for taking part in this experiment, your participation has been most valuable. Due to this being the early stage of the experiment, no data has been analyzed yet, but work already completed in this area suggests that moderate exercise can be beneficial in those attempting to stop smoking i.e. by reducing cigarette cravings.

If you have any questions or worries do not hesitate to contact me. This project will be finished by the end of November, if you wish to know what the experiment found then the results will be made available to you.

Thanks again

James Daniel

Tel. 01483 68 ext 2889 J.Daniel@surrey.ac.uk
## Appendix 9

**Change score repeated measures ANOVA – study 1**

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<th>Group</th>
<th>Time * group</th>
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<td>df</td>
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<td>&lt;.001</td>
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1. **Would you say you have a desire for a cigarette right now?**

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<td>Condition 10 mins</td>
<td>1 2 3 4 5 6 7</td>
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<tr>
<td>Condition 15 mins</td>
<td>1 2 3 4 5 6 7</td>
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<td>Condition 20 mins</td>
<td>1 2 3 4 5 6 7</td>
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2. **How irritable do you feel right now?**

<table>
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<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control 5 mins</td>
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<td></td>
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<tr>
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<td>1 2 3 4 5 6 7</td>
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<tr>
<td>Condition 5 mins</td>
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<tr>
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<td></td>
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<td>Condition 15 mins</td>
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3. How depressed do you feel right now?

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<tr>
<td>Control 10 mins:</td>
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<td>2</td>
<td>3</td>
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<tr>
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</tr>
<tr>
<td>Condition 10 mins</td>
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<tr>
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<td>2</td>
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<td>Condition 20 mins</td>
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4. How tense do you feel right now?

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5. How restless do you feel right now?

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<tbody>
<tr>
<td>Control 0 mins</td>
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<tr>
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<td>Condition 10 mins</td>
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6. Do you find it difficult to concentrate right now?

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7. How stressed do you feel right now?

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<td>Control 10 mins:</td>
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<tr>
<td>Condition 15 mins</td>
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</tr>
<tr>
<td>Condition 20 mins</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
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8. How strong is your desire to smoke right now?

<table>
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<th></th>
<th>Not at all</th>
<th>Somewhat</th>
<th>Extremely</th>
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</thead>
<tbody>
<tr>
<td>Control 0 mins</td>
<td>1 2 3 4 5 6 7</td>
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<tr>
<td>Condition 20 mins</td>
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Appendix II

Short Positive and Negative Affect Schedule (PANAS)

This scale consists of a number of words that describe different feelings and emotions. Each item will be read to you, you will then tell me a number on the scale I will present to you, indicating the extent to which you feel this way, right now.

**CONTROL - BASELINE (0 minutes)**

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<thead>
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<th></th>
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<th>moderately</th>
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<tr>
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CONTROL (5 minutes)

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CONTROL (10 minutes)

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### CONDITION - (10 minutes)

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<td>5</td>
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</tr>
<tr>
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### CONDITION (15 minutes)

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<th>quite a bit</th>
<th>extremely</th>
</tr>
</thead>
<tbody>
<tr>
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<td>4</td>
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<tr>
<td>UPSET</td>
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<td>2</td>
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<td>4</td>
<td>5</td>
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<tr>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<td>5</td>
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<tr>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<tr>
<td>DETERMINED</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>AFRAID</td>
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### CONDITION - (20 minutes)

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<th>moderately</th>
<th>quite a bit</th>
<th>extremely</th>
</tr>
</thead>
<tbody>
<tr>
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<td>2</td>
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<td>4</td>
<td>5</td>
</tr>
<tr>
<td>EXCITED</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>UPSET</td>
<td>1</td>
<td>2</td>
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<td>4</td>
<td>5</td>
</tr>
<tr>
<td>SCARED</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>ENTHUSIASTIC</td>
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<td>4</td>
<td>5</td>
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<tr>
<td>ALERT</td>
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<td>2</td>
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<td>4</td>
<td>5</td>
</tr>
<tr>
<td>INSPIRED</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>NERVOUS</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>DETERMINED</td>
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<td>5</td>
</tr>
<tr>
<td>AFRAID</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Appendix 12

Enjoyment and discomfort questions

Enjoyment of the Exercise

How much did you enjoy doing the exercise?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>A little</th>
<th>Somewhat</th>
<th>Very much so</th>
<th>Extremely so</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Discomfort Associated with Exercise

How much discomfort did you feel during the exercise?

<table>
<thead>
<tr>
<th>Just noticeable</th>
<th>Very slightly</th>
<th>Moderate</th>
<th>Severe</th>
<th>Very severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Information for prospective Participants

The aim of the study is to investigate the effects of a short bout of moderate exercise on how you are feeling and how this compares to taking part in a short cognitive (thinking) task. You will be asked not to smoke for between 12-14 hours (overnight), you will then be asked to take part in one of two conditions, described below. The entire test procedure will take approximately 45 minutes. At the start of the test you will be asked to blow into a machine that measures your exposure to cigarette smoke. **The aim will be to confirm you have not smoked.** You will then be allocated to one of two conditions.

1) First you will fill out a number of questionnaires, concerning the amount of exercise you do, your motivation to quit and how you feel. After this initial questioning session you will sit quietly for 10 minutes. Every few minutes you will be asked to complete a questionnaire. You will then complete an exercise session, consisting of 10 minutes of moderate intensity exercise. In order to monitor your heart rate you will need to wear a chest-band. The experimenter will explain how this equipment works to you. Every few minutes you will be asked to complete a questionnaire. You will then sit quietly for a further 10 minutes.

2) First you will fill out a number of questionnaires, concerning the amount of exercise you do, your motivation to quit and how you feel. After this initial
questioning session you will sit quietly for 10 minutes. Every few minutes you will be asked to complete a questionnaire. You will then be asked to begin a cognitive task, consisting of 10 minutes of simple addition. In order to monitor your heart rate you will need to wear a chest-band. The experimenter will explain how this equipment/task works, to you. Every few minutes you will be asked to complete a questionnaire. You will then sit quietly for a further 10 minutes.

If at any point during either condition you feel uncomfortable or no longer wish to take part you are free to withdraw from the study at any point during the experiment.

As compensation you will be paid £10.00 for taking part. If you have any queries please phone James Daniel on 07946007345 – or e-mail J.Daniel@surrey.ac.uk
Debriefing Sheet.

I would like to take this opportunity to thank you for taking part in this experiment, your participation has been most valuable. Due to this being the early stage of the experiment, no data has been analyzed yet, but work already completed in this area suggests that moderate exercise can be beneficial in those attempting to stop smoking i.e. a reduction in cigarette cravings. The issue I am investigating here is whether distraction is effective at reducing cravings compared to moderate exercise.

If you have any questions or worries do not hesitate to contact me. If you wish to know what the experiment found then the results will be made available to you once the study has been completed.

Thanks again

James Daniel

Tel. 01483 87 ext 3971  J.Daniel@surrey.ac.uk
### Appendix 15

**Change score repeated measures ANOVA – Study 2**

<table>
<thead>
<tr>
<th>Q</th>
<th>Time</th>
<th>Group</th>
<th>Time * group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F value</td>
<td>df</td>
<td>P value</td>
</tr>
<tr>
<td>Q1) Desire for A cigarette</td>
<td>5.598</td>
<td>3.4</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Q2) Irritability</td>
<td>8.577</td>
<td>3.4</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Q3) Depression</td>
<td>1.472</td>
<td>5</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Q4) Tension</td>
<td>1.941</td>
<td>1.3</td>
<td>=.168</td>
</tr>
<tr>
<td>Q5) Restlessness</td>
<td>1.161</td>
<td>4</td>
<td>=.330</td>
</tr>
<tr>
<td>Q6) Difficulty concentrating</td>
<td>2.847</td>
<td>3.8</td>
<td>=.562</td>
</tr>
<tr>
<td>Q7) Stress</td>
<td>5.056</td>
<td>3.7</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Q8) Strength Of desire to smoke</td>
<td>3.606</td>
<td>3.6</td>
<td>&lt;.05</td>
</tr>
</tbody>
</table>

(df = degrees of freedom)
Investigation into smoking motivation and attitude to exercise

Information Sheet.

The aim of this study is to measure reasons for smoking amongst smokers and attitudes to exercise. The experiment is in two stages: the first stage involves filling out the questionnaire provided and returning it to me via the enclosed SAE. There is a second stage to this study although filling out the questionnaire does not mean you have to complete this second stage, you can indicate if you are interested in taking part in stage 2 at the end of the questionnaire. Based on results from the questionnaire you may be asked to participate in a session of exercise at the University of Surrey. By completing both stages of the experiment you will be paid £15.00. Below is a more detailed description of what the study entails.

Stage 1:
You will fill in the questionnaire book provided, it takes approximately 20 minutes to complete. Once you have done this please return it to me via the self-addressed envelope. Participation is entirely voluntary, by filling out the questionnaire and returning the questionnaire it does not mean you have to complete the second stage of the experiment. There is a section at the end of the questionnaire where you can state if you wish to be considered to take part in the second part of the experiment.
Stage 2:
You will be contacted once your completed questionnaire has been received to ask if you still wish to take part in the second stage of the experiment. If you do wish to take part you will be asked not to smoke for between 12-14 hours (overnight), and then come to the University of Surrey the next day. Once in the smoking lab first you will fill out a number of questionnaires, concerning the amount of exercise you do, your motivation to quit and how you feel. After this initial questioning session you will sit quietly for 10 minutes. Every few minutes you will be asked to complete a questionnaire. You will then complete an exercise session, consisting of 10 minutes of moderate intensity exercise. In order to monitor your heart rate you will need to wear a chest-band. The experimenter will explain how this equipment works to you. Every few minutes you will be asked to complete a questionnaire. You will then sit quietly for a further 10 minutes. The entire test procedure will take approximately 45 minutes. At the start of the test you will be asked to blow into a machine that measures your exposure to cigarette smoke. The aim will be to confirm you have not smoked.

If at any point during the exercise condition you feel uncomfortable or no longer wish to take part you are free to withdraw from the study at any point during the experiment, without having to explain why.

All questionnaires and data from both stages of the study will be kept strictly confidential, with data only being available to the principle investigator. This is in accordance with the Data Protection Act 1998.

As compensation for completing BOTH the questionnaire and taking part in the exercise condition you will be paid £15.00 for taking part.

If you have any queries please phone James Daniel on 07946007345 or 01483682889 or e-mail J.Daniel@surrey.ac.uk
Investigation into smoking motivation and attitude to exercise

Stage 2: Moderate exercise condition

Information Sheet.

The aim of this study is to measure reasons for smoking amongst smokers and attitudes to exercise. You will have already completed a questionnaire concerning your attitudes to smoking and exercise. This second stage of the experiment involves taking part in a 10 minute session of supervised exercise, of a moderate intensity on a stationary exercise bike.

If you do wish to take part you will be asked not to smoke for between 12-14 hours (overnight), and then come to the University of Surrey the next day. Once in the smoking lab first you will fill out a number of questionnaires, concerning the amount of exercise you do, your motivation to quit and how you feel. After this initial questioning session you will sit quietly for 10 minutes. Every few minutes you will be asked to complete a questionnaire. You will then complete an exercise session, consisting of 10 minutes of moderate intensity exercise. In order to monitor your heart rate, you will need to wear a chest-band. The experimenter will explain how this equipment works to you. Every few minutes you will be asked to complete a questionnaire. You will then sit quietly for a further 10 minutes. The entire test procedure will take approximately 35 minutes. At the start of the test you will be asked to blow into a machine that measures your exposure to cigarette smoke. The aim will be to confirm you have not smoked.
If at any point during the exercise condition you feel uncomfortable or no longer wish to take part you are free to withdraw from the study at any point during the experiment, without having to explain why.

All questionnaires and data from the exercise condition will be kept strictly confidential, with data only being available to the principle investigator. This is in accordance with the Data Protection Act 1998.

As compensation for taking part in the exercise condition you will be paid £15.00 for taking part.

If you have any queries please phone James Daniel on 07946007345 or 01483682889 or e-mail J.Daniel@surrey.ac.uk
INVESTIGATION INTO SMOKING MOTIVATION AND ATTITUDES TO EXERCISE

Questionnaire

Thank you for agreeing to help with the research. This questionnaire has been designed to measure your thoughts and feelings about your smoking behaviour and physical activity. Please answer each question truthfully. Your answers will be kept in the strictest confidence.

First could you provide us with some background information:

Age.

Sex (please circle one)  M  /  F

Occupation

The following question is concerned with how you feel about exercise. By circling one number only, please state, which of the following statements most accurately describes how you feel at present about being physically active. I am only interested in exercise which makes you breathe even slightly more than normal and feels at least as hard as when having a brisk walk:

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I do not exercise regularly and I do not intend to start in the next 6 months</td>
</tr>
<tr>
<td>2</td>
<td>I do not exercise regularly but I intend to start in the next 6 months</td>
</tr>
<tr>
<td>3</td>
<td>I do some exercise but not regularly</td>
</tr>
<tr>
<td>4</td>
<td>I exercise regularly but I have been doing so for less than 6 months</td>
</tr>
<tr>
<td>5</td>
<td>I have exercised regularly for 6 months or longer.</td>
</tr>
<tr>
<td>6</td>
<td>I used to exercise regularly but I have not done so for at least 12 months</td>
</tr>
</tbody>
</table>
Please answer the following questions: *(Circle one response for each question)*

Do you want to stop smoking for good? 
- No
- Yes, quite
- Yes, very much

Do you intend to make a serious attempt to stop smoking in the next 3 months?
- No
- Maybe
- Yes

*Please mark in the box number of times*
In the last year, how many times have you quit smoking for at least 24 hours?

*Please tick one box*
Are you seriously thinking of quitting smoking?
- Yes, within the next 30 days
- Yes, within the next 6 months
- No, not thinking of quitting

*The following questions are concerned with your smoking*

How many cigarettes per day do you usually smoke? ......

How soon after you wake up do you smoke your first cigarette? *(circle one response)*
- within 5 minutes
- 6-30 minutes
- 31 or more

Do you find it difficult to stop smoking in no-smoking areas? *(circle one response)*
- NO
- YES

Which cigarette would you most hate to give up? *(circle one response)*
- The first in the morning
- Another

Do you smoke more frequently in the first hours after waking than during the rest of the day? *(circle one response)*
- NO
- YES

Do you smoke even if you are so ill that you are in bed most of the day? *(circle one response)*
- NO
- YES

Approximately how many years have you been smoking? 299

*Please write in box*
These questions consist of a number of words that describe different feelings and emotions. Read each word then circle only one statement next to each word, indicating the extent to which you have felt this way over the past three months:

<table>
<thead>
<tr>
<th>Emotion</th>
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<th>a little</th>
<th>moderately</th>
<th>quite a bit</th>
<th>extremely</th>
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</thead>
<tbody>
<tr>
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<td>UPSET</td>
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<td>SCARED</td>
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<td>ALERT</td>
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<td>INSPIRED</td>
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<tr>
<td>NERVOUS</td>
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<td>DETERMINED</td>
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<tr>
<td>AFRAID</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These questions are concerned with your reasons for smoking. Read each question then circle the appropriate response for you, next to the question.

1. I get a definite craving to smoke when I have to stop for a while
   Not at all a bit sometimes often very much so

2. I still have one burning in the ashtray
   Not at all a bit sometimes often very much so

3. I like a cigarette best when I am having a quite rest
   Not at all a bit sometimes often very much so

4. I get a definite pleasure whenever I smoke
   Not at all a bit sometimes often very much so

5. I smoke more when I am worried about something
   Not at all a bit sometimes often very much so

6. I get a definite lift and feel more alert when smoking
   Not at all a bit sometimes often very much so

7. I smoke automatically without even being aware of it
   Not at all a bit sometimes often very much so

8. When I have run out of cigarettes I find it almost unbearable until I get them
   Not at all a bit sometimes often very much so

9. I smoke more when I am unhappy
   Not at all a bit sometimes often very much so
10. Smoking helps to keep me going when I am tired

<table>
<thead>
<tr>
<th>Not at all</th>
<th>a bit</th>
<th>sometimes</th>
<th>often</th>
<th>very much so</th>
</tr>
</thead>
</table>

11. I find it difficult to go as long as an hour without smoking

<table>
<thead>
<tr>
<th>Not at all</th>
<th>a bit</th>
<th>sometimes</th>
<th>often</th>
<th>very much so</th>
</tr>
</thead>
</table>

12. I find myself smoking without remembering lighting up

<table>
<thead>
<tr>
<th>Not at all</th>
<th>a bit</th>
<th>sometimes</th>
<th>often</th>
<th>very much so</th>
</tr>
</thead>
</table>

13. I want to smoke most when I am comfortable and relaxed

<table>
<thead>
<tr>
<th>Not at all</th>
<th>a bit</th>
<th>sometimes</th>
<th>often</th>
<th>very much so</th>
</tr>
</thead>
</table>

14. Smoking helps me to think and concentrate

<table>
<thead>
<tr>
<th>Not at all</th>
<th>a bit</th>
<th>sometimes</th>
<th>often</th>
<th>very much so</th>
</tr>
</thead>
</table>

15. I get a real gnawing hunger to smoke when I haven’t smoked for a while

<table>
<thead>
<tr>
<th>Not at all</th>
<th>a bit</th>
<th>sometimes</th>
<th>often</th>
<th>very much so</th>
</tr>
</thead>
</table>

16. I am very much aware of the fact when I am not smoking

<table>
<thead>
<tr>
<th>Not at all</th>
<th>a bit</th>
<th>sometimes</th>
<th>often</th>
<th>very much so</th>
</tr>
</thead>
</table>

17. I would find it difficult to go without smoking for as long as a week

<table>
<thead>
<tr>
<th>Not at all</th>
<th>a bit</th>
<th>sometimes</th>
<th>often</th>
<th>very much so</th>
</tr>
</thead>
</table>

18. I light up a cigarette when I feel angry about something

<table>
<thead>
<tr>
<th>Not at all</th>
<th>a bit</th>
<th>sometimes</th>
<th>often</th>
<th>very much so</th>
</tr>
</thead>
</table>

Please answer the following questions (Circle one response for each question):

1. Do you use smoking to help you socialise? Yes very much | Yes quite a bit | Yes a little | Not really | Not at all

2. Do you use smoking to give you something to do when you are bored? Yes very much | Yes quite a bit | Yes a little | Not really | Not at all

3. Do you use smoking to help you to concentrate and stay alert? Yes very much | Yes quite a bit | Yes a little | Not really | Not at all

4. Do you smoke because you feel uncomfortable if you don’t? Yes very much | Yes quite a bit | Yes a little | Not really | Not at all

5. Do you use smoking to help you keep your weight down? Yes very much | Yes quite a bit | Yes a little | Not really | Not at all

6. Do you use smoking to help you cope with stress? Yes very much | Yes quite a bit | Yes a little | Not really | Not at all

7. Do you enjoy smoking? Yes very much | Yes quite a bit | Yes a little | Not really | Not at all

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We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and garden work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

   ____________ days per week
   
   [ ] No vigorous physical activities  → Skip to question 3

2. How much time did you usually spend doing vigorous physical activities on one of those days?

   ____________ hours per day
   ____________ minutes per day

   [ ] Don’t know/Not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

   ____________ days per week
   
   [ ] No moderate physical activities  → Skip to question 5

4. How much time did you usually spend doing moderate physical activities on one of those days?

   ____________ hours per day
   ____________ minutes per day

   [ ] Don’t know/Not sure
Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

   days per week

[ ] No walking  →  Skip to question 7

6. How much time did you usually spend walking on one of those days?

   hours per day
   minutes per day

[ ] Don't know/Not sure

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the last 7 days, how much time did you spend sitting on a week day?

   hours per day
   minutes per day

[ ] Don't know/Not sure

How much physical activity did you do last week compared to the previous 3 months?

(circle one number only)

<table>
<thead>
<tr>
<th>Much less</th>
<th>Less</th>
<th>About the same</th>
<th>More</th>
<th>Much more</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
These questions are about your attitude to exercise: 'How much do you agree with the following statements?'

(a) Exercise is very important for my physical health (circle one response)

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
</table>

(b) Exercise is very important for my mental health (circle one response)

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
</table>

(c) 'How much do you enjoy exercise?' (circle one response)

<table>
<thead>
<tr>
<th>Not at all</th>
<th>A little</th>
<th>Somewhat</th>
<th>Very much so</th>
<th>Extremely so</th>
</tr>
</thead>
</table>

Thank you for completing this questionnaire. Please return it in the self addressed envelope provided. If you wish to be considered to take part in the second stage of the experiment please provide your name and contact telephone, e-mail, address (you will be paid £15.00 for taking part in the second stage):

Once I have collected all questionnaires I will contact people to ask them to take part in stage two of the experiment if you express a wish to take part and subsequently change your mind then that is fine, completion of both stages of this experiments is entirely voluntary.

If interested in taking part in the second stage of the experiment please complete your details below:

Name:

Contact telephone number:

Address:
Appendix 19

Scree plot for SMQ factor analysis

Scree Plot

![Scree Plot Image](image-url)
Appendix 20

Scree plot for West et al (1999) motivation questions factor analysis
Appendix 21
Credibility scale – Study 3b

‘How logical do you consider this approach to smoking cessation to be’?

0  1  2  3  4  5  6  7  8  9  10
(Not at all) (Completely)

‘How certain are you that this method will be successful in reducing your desire to smoke and withdrawal symptoms?’

0  1  2  3  4  5  6  7  8  9  10
(Not at all) (Completely)

‘With what degree of confidence would you recommend this approach to a friend who is trying to stop smoking?’

0  1  2  3  4  5  6  7  8  9  10
(None at all) (Total)
Debriefing Sheet.

I would like to take this opportunity to thank you for taking part in this experiment. Your participation has been most valuable. As the experiment is at an early stage no data has been analysed yet but work already completed in this area suggests that moderate exercise can be beneficial in those attempting to stop smoking i.e. reducing cigarette cravings. The issue I am investigating here is whether different motivation to smoke has an effect on any reductions in cravings observed following exercise.

If you have any questions or worries do not hesitate to contact me. If you wish to know what the experiment found then the results will be made available to you once the study has been completed.

Thanks again

James Daniel

Tel. 0148368 ext 6889 J.Daniel@surrey.ac.uk
### Appendix 23

Change score repeated measures ANOVA study 3b

<table>
<thead>
<tr>
<th>Question</th>
<th>Time</th>
<th>Group</th>
<th>Time * Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F value</td>
<td>df</td>
<td>P value</td>
</tr>
<tr>
<td>Q1) Desire for A cigarette</td>
<td>12.542</td>
<td>5</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Q2) Irritability</td>
<td>6.257</td>
<td>5</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Q3) Depression</td>
<td>5.376</td>
<td>5</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Q4) Tension</td>
<td>5.813</td>
<td>5</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Q5) Restlessness</td>
<td>2.775</td>
<td>5</td>
<td>&lt; .05</td>
</tr>
<tr>
<td>Q6) Difficulty concentrating</td>
<td>2.165</td>
<td>5</td>
<td>= .060</td>
</tr>
<tr>
<td>Q7) Stress</td>
<td>7.516</td>
<td>5</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Q8) Strength Of desire to smoke</td>
<td>14.571</td>
<td>5</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

(df = degrees of freedom)
The following questions refer to different methods for aiding quitting smoking. For each question please rate what you think about each approach on the scales provided below each question.

1. 'How logical do you consider using Nicotine patches as a smoking cessation aid to be'?

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Not at all)</td>
<td></td>
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<td>(Completely)</td>
</tr>
</tbody>
</table>

2. 'How certain are you that Nicotine patches will be successful in reducing your desire to smoke and withdrawal symptoms'?

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<td></td>
<td></td>
<td></td>
<td>(Completely)</td>
</tr>
</tbody>
</table>

3. 'With what degree of confidence would you recommend using Nicotine patches to a friend who is trying to stop smoking'?

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>(None at all)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>(Total)</td>
</tr>
</tbody>
</table>

4. 'How logical do you consider using Hypnotherapy as a smoking cessation aid to be'?

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<th>10</th>
</tr>
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<tbody>
<tr>
<td>(Not at all)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>(Completely)</td>
</tr>
</tbody>
</table>
5. ‘How certain are you that Hypnotherapy will be successful in reducing your desire to smoke and withdrawal symptoms?’

0 1 2 3 4 5 6 7 8 9 10
(Not at all) (Completely)

6. ‘With what degree of confidence would you recommend using Hypnotherapy to a friend who is trying to stop smoking?’

0 1 2 3 4 5 6 7 8 9 10
(None at all) (Total)

7. ‘How logical do you consider using exercise as a smoking cessation aid to be’?

0 1 2 3 4 5 6 7 8 9 10
(Not at all) (Completely)

8. ‘How certain are you that exercise will be successful in reducing your desire to smoke and withdrawal symptoms?’

0 1 2 3 4 5 6 7 8 9 10
(Not at all) (Completely)

9. ‘With what degree of confidence would you recommend using exercise to a friend who is trying to stop smoking?’

0 1 2 3 4 5 6 7 8 9 10
(None at all) (Total)
10. ‘How logical do you consider using meditation as a smoking cessation aid to be’?

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<th>7</th>
<th>8</th>
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</tr>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>Completely</td>
</tr>
</tbody>
</table>

11. ‘How certain are you that meditation will be successful in reducing your desire to smoke and withdrawal symptoms?’

<table>
<thead>
<tr>
<th>0</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>Completely</td>
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</tbody>
</table>

12. ‘With what degree of confidence would you recommend using meditation to a friend who is trying to stop smoking?’

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>None at all</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total</td>
</tr>
</tbody>
</table>
Investigation into attitudes to exercise and smoking and the effect of 10 minutes of moderate intensity exercise on mood.

Information Sheet.

The aim of the study is to investigate the effects of a short bout of moderate exercise on how you are feeling and your attitude to exercise in general. The experiment involves taking part in a 10 minute session of supervised exercise, of a moderate intensity on a stationary exercise bike.

If you do wish to take part you will be asked not to smoke for between 12-14 hours (overnight), and then come to the University of Surrey the next day. Once in the smoking lab first you will fill out a number of questionnaires, concerning the amount of exercise you do, your motivation to quit and how you feel. After this initial questioning session you will sit quietly for 10 minutes. Every few minutes you will be asked to complete a questionnaire. You will then complete an exercise session, consisting of 10 minutes of moderate intensity exercise. In order to monitor your heart rate, you will need to wear a chest-band. The experimenter will explain how this equipment works to you. Every few minutes you will be asked to complete a questionnaire. You will then sit quietly for a further 10 minutes. The entire test procedure will take approximately 45 minutes. At the start of the test you will be asked to blow into a machine that measures your exposure to cigarette smoke. The aim will be to confirm you have not smoked.

If at any point during the exercise condition you feel uncomfortable or no longer wish to take part you are free to withdraw from the study at any point during the experiment, without having to explain why.
All questionnaires and data from the exercise condition will be kept strictly confidential, with data only being available to the principle investigator. This is in accordance with the Data Protection Act 1998.

As compensation for taking part in the exercise condition you will be paid £10.00 for taking part.

If you have any queries please phone James Daniel on 07946007345 or 0148368 2889 or e-mail J.Daniel@surrey.ac.uk
Investigation into attitudes to exercise and smoking and the effect of 10 minutes of moderate intensity exercise on mood.

Research conducted and published by Ussher, West and Taylor (2001) and Daniel, Cropley, Ussher and West (2004) suggests exercise can be beneficial for smokers attempting to give up smoking. Specifically they have found that completing just 10 minutes of moderate intensity exercise produces significant reductions in negative mood and desire to smoke in smokers who had just given up. Exercise has begun to be used in specialized smoking cessation clinics as a result of this research.

This study aims to investigate this further, with the objective of providing more evidence for the beneficial use of exercise in smokers who have just given up. It is expected that 10 minutes of moderate intensity exercise will result in reductions in cravings and withdrawal symptoms associated with short-term smoking abstinence.
Investigation into attitudes to exercise and smoking and the effect of 10 minutes of moderate intensity exercise on mood.

Research conducted and published by Ussher, West and Taylor (2001) and Daniel, Cropley, Ussher and West (2004) suggests exercise can be beneficial for smokers attempting to give up smoking. Specifically they have found that completing just 10 minutes of moderate intensity exercise produces significant reductions in negative mood and desire to smoke in smokers who had just given up. Research however by Pomerleau and Pomerleau (1984) and Marcus and Katomeri (2000) has suggested that this is not the case. They found no effect of 10 minutes of moderate intensity exercise on withdrawal symptoms and desire to smoke in abstinent smokers.

This study aims to investigate this further, with the objective of testing these studies findings, either confirming or disconfirming the usefulness of exercise at reducing withdrawal symptoms. This study will implement 10 minutes of moderate intensity exercise, the result of which at this stage is unclear.
Investigation into attitudes to exercise and smoking and the effect of 10 minutes of moderate intensity exercise on mood.

Research conducted and published by Pomerleau and Pomerleau (1984) and Marcus and Katomeri (2000) has suggested that exercise is not particularly beneficial to smokers who have just given up. They found no effect of 10 minutes of moderate intensity exercise on withdrawal symptoms and desire to smoke in abstinent smokers. However research by Ussher, West and Taylor (2001) and Daniel, Cropley, Ussher and West (2004) suggests exercise can be beneficial for smokers attempting to give up smoking. Specifically they have found that completing just 10 minutes of moderate intensity exercise produces significant reductions in negative mood and desire to smoke in smokers who had just given up.

This study aims to investigate this further, with the objective of testing these research findings. This study will implement 10 minutes of moderate intensity exercise. At this stage it is unclear if this will have any affect upon withdrawal symptoms and desire to smoke.
Investigation into attitudes to exercise and smoking and the effect of 10 minutes of moderate intensity exercise on mood.

Research conducted and published in America by Pomerleau and Pomerleau (1984) and Marcus and Katomeri (2000) suggests exercise is not beneficial for smokers attempting to give up smoking. Specifically they have found that completing just 10 minutes of moderate intensity exercise produces no significant reductions in negative mood and desire to smoke in smokers who had just given up. Exercise has therefore not been used in specialized smoking cessation clinics as a result of this research.

This study aims to investigate this further, with the objective of verifying these results in a UK sample. It is expected that 10 minutes of moderate intensity exercise will have no effect on cravings and withdrawal symptoms associated with short-term smoking abstinence.
I would like to take this opportunity to thank you for taking part in this experiment, your participation has been most valuable. Due to this being the early stage of the experiment, no data has been analyzed yet, but work already completed in this area suggests that moderate exercise can be beneficial in those attempting to stop smoking i.e. a reduction in cigarette cravings. The issue I am investigating here is whether expectation of the effects of exercise on mood is related to any reductions in withdrawal and desire to smoke following exercise.

If you have any questions or worries do not hesitate to contact me. If you wish to know what the experiment found then the results will be made available to you once the study has been completed.

Thanks again

James Daniel

Tel. 01483 68 ext 2889 J.Daniel@surrey.ac.uk
**Appendix 30**

Change score repeated measures ANOVA study 4

<table>
<thead>
<tr>
<th></th>
<th>Time</th>
<th>Group</th>
<th>Time * Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F value</td>
<td>df</td>
<td>P value</td>
</tr>
<tr>
<td>Q1) Desire for A cigarette</td>
<td>34.16</td>
<td>3</td>
<td>p&lt;.001</td>
</tr>
<tr>
<td>Q2) Irritability</td>
<td>14.74</td>
<td>7</td>
<td>p&lt;.001</td>
</tr>
<tr>
<td>Q3) Depression</td>
<td>5.713</td>
<td>5</td>
<td>p&lt;.001</td>
</tr>
<tr>
<td>Q4) Tension</td>
<td>10.44</td>
<td>4</td>
<td>p&lt;.001</td>
</tr>
<tr>
<td>Q5) Restlessness</td>
<td>4.864</td>
<td>5</td>
<td>p&lt;.001</td>
</tr>
<tr>
<td>Q6) Difficulty</td>
<td>4.599</td>
<td>5</td>
<td>p&lt;.001</td>
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<tr>
<td>Q6) Difficulty</td>
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<tr>
<td>Q7) Stress</td>
<td>10.00</td>
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<td>p&lt;.001</td>
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<tr>
<td>Q8) Strength</td>
<td>29.98</td>
<td>5</td>
<td>p&lt;.001</td>
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</tbody>
</table>

(df= degrees of freedom)