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Cognitive and Attentional Bias in the Processing of Smoking-Related Stimuli

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Abstract

The aim of the present thesis was to examine the cognitive and attentional processing of smoking-related stimuli in abstinent, active and non-smokers. The initial research reported here is directed at establishing appropriate experimental and questionnaire materials for the main studies. This included the development of a valid list of smoking-related words with frequency-matched controls, and revising the Smoking Motivation Questionnaire based on analyses of structure and reliability.

Generalised cognitive biases were assessed through a series of modified Stroop experiments. Although the findings suggested that abstinence alters cognition with respect to smoking-related stimuli an assessment of the results suggested that there were some inconsistencies in the findings. Only when a blocked-format Stroop with vocal responses was used was there evidence of a cognitive bias for smoking-related words in abstinent smokers. In order to specifically examine attentional bias in abstinent, active and non-smokers a final study assessed performance on a Dot Probe task. Results showed no shift in attention towards smoking words in abstinent smokers. However, a subsidiary analysis revealed that smokers who reported an awareness of smoking shifted their attention towards smoking words. These findings may suggest that different formats of attentional tasks provide differing outcomes in terms of smokers processing of smoking-related information, and that awareness is an important aspect of this processing. Finally, analyses of self-report measures revealed that smokers were more state anxious than smokers and that abstinence increased state anxiety and cigarette craving.

The results from this thesis have provided some useful indicators of successful smoking cessation and may assist in the development of a cognitive model of smoking. However, the development of the work will be dependent on modifications and extensions needed to address the anomalies in the findings. Specifically the smoking-related words used and the type of attentional task employed.

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Contents

Chapter One

Theories of Smoking Behaviour

'Sometimes, a cigar is just a cigar'
Sigmund Freud[1]

1. Overview

The initial aims of this chapter are to review the history of smoking behaviour and provide an overview of smoking prevalence statistics. This is followed by a description and evaluation of theories of addiction that are relevant to smoking behaviour. Finally, it will be argued that theories which consider the role of smoking-related stimuli to be important factors in the maintenance of addiction to smoking are central to a more definitive understanding of the smoking behaviour.

1.2 A brief history of smoking

Since the discovery of the special properties of the tobacco leaf in central America by the Mayan Indians in about 470-620 A.D. (and its subsequent introduction to the Europe following the discovery of the Americas by Columbus) there has been a relentless increase in the use of tobacco. Tobacco was introduced to England in 1560, and despite efforts to suppress it by James I and Oliver Cromwell, it became an accepted social behaviour. In England smoking was popularised mainly by Sir Walter Raleigh who introduced tobacco through his presence in the royal court. In comparison, Raleigh's other offering to the people of Europe, the humble potato, had to have its use enforced and took some one hundred years to be widely accepted (England, 1996). A contemporary commentator noted:

> 'As an ignorant child, if offered the choice between a piece of bread and a glowing coal, stretches out his hand first to the latter, even so did the people of Europe choose between potatoes and tobacco...' (Count Corti, In England, 1996, p.73).

[1] Freud smoked cigars nearly all his adult life, and died from throat cancer.

Pipe smoking was quickly assimilated into the rituals of high social living and became a status symbol for the rich and aristocratic. By the late 18th century the major importers and manufacturers of tobacco products were established multi- million dollar companies with significant world-wide influence. They controlled the cultivation, production, distribution and sale of tobacco products such as cigars, pipe tobacco, and later the cigarette. Moreover, government quickly realised that tobacco taxation was an effective way of raising revenue. Thus government played a significant role in the popularisation and widespread use of tobacco. For example, in the 1940s and 1950s, in Britain and America the medical establishments portrayed smoking as a health benefiting behaviour. In the two world wars cigarettes were distributed to soldiers as part of their rations and smoking was considered important for maintaining morale. This helped to establish a whole generation of smokers, and those who survived the trenches returned home as addicted smokers. At this time there was no widespread awareness of the dangers of smoking, or any significant understanding of the effects of nicotine on the human body. The harmful side effects from the major pollutants and carcinogenic agents present in cigarette smoke were also not recognised or understood.

The last 400-500 years have witnessed the globalisation of the use of tobacco. Its use has become more ubiquitous than alcohol and companies spend billions on marketing their tobacco products. Despite the best efforts of organisations to reduce smoking rates and decisions by governments to limit the scope and style of tobacco advertising smoking in world-wide terms continues to grow. With the shrinking of the US and UK smoking population, new Far Eastern and Pacific Rim markets have emerged and continue to grow. There are now an estimated billion smokers in the world today, of which one third of them are from China. By 1985 sales of cigarettes had doubled over 30 years in a number of developing countries. Tobacco consumption has also increased in many developed countries (France, Germany, Austria, Denmark, Sweden, Greece, Italy, Spain, Portugal and Japan) but has decreased in others (United Kingdom, Finland, The Netherlands, Switzerland, Australia, Canada, and North America.) Smoking in young adults is on the increase, leading to an overall rise in adult smoking prevalence in 1996 after 24 years of steady decline. Research suggests that most smokers begin in their teenage years, at a time when the prospect of illness and death in adult life seems remote and the known risks are not prominent in their mind. Some eventually give up the habit, but for many the intractability of smoking behaviour reflects the fact that nicotine is a powerful drug of addiction (Office, 1997; Office, 1998).

The statistics presented above make research into the causes and initiation of smoking (and how best to help people quit) a cardinal task for organisations such as the World Health Organisation, primary health care workers, health promotion workers and health psychologists. As part of this endeavour research and theorising into smoking has to address the issue of the nature of addiction and adopt a stance which provides a bedrock theoretical background for a research project. One of the long standing problems in smoking research has been to provide a theory of smoking which covers the broad range of factors found in smoking behaviour. A primary aim of any theory of smoking is its ability to describe and include the factors that determine smoking initiation, smoking maintenance, smoking cessation and relapse. Peele (1985) offers an insight into the complexity and difficulty of research into the addictions (which can be applied to smoking) when he states;

> 'A successful addiction model must synthesize pharmacological, experiential, cultural, situational, and personality components in a fluid and seamless description of addictive motivation. It must account for why one drug is more addictive than another, addictive for one individual and not another, and addictive for the same individual at one time and not another. The model must make sense out of the essentially similar behaviour that takes place with all compulsive involvements. In addition, the model must adequately describe the cycle of increasing yet dysfunctional reliance on an involvement until the involvement overwhelms other reinforcements available to the individual' (1985, p.72)

At present this model has not been rigorously tested or applied to a range of 'compulsive involvements' or as Peele prefers 'addictive behaviours'. As Pomerleau and Pomerleau, (1988) point out, the question is where to start and how best to deploy finite resources.

1.3 Models of Addiction

Given the health consequences of smoking and the compulsive nature of the behaviour, smoking must be understood as an addiction. However, this understanding is obscured by the controversial and problematic nature of this term. It has been used to describe a range of behaviours, associated with strong habits or compulsions. Given the imprecise use of the term it is not surprising contemporary theorists disagreed on how best to define the concept. Some offer narrow physiological and pharmacological interpretations (Schachter, 1977,1978) whilst others proffer broader definitions of addiction that remove theorising from a linear, idiographic and medicalised stance (Peele, 1985; Peele, 1998).

It is claimed that the medicalisation of the term resulted from a desire to control (through legislation) narcotic use in the late 19th and early 20th century (Peele, 1998). The medical model provided the justification for the social control of opiate users from immigrant Asian minorities in the USA and eventually led to the labelling of opiate use or abuse as a syndrome and a recognisable medical disease. Thus the term addiction had been brought into medical nomenclature. The continued embodiment of the medical model, and the pharmacological addiction based approach has been criticised by many theorists, (Peele, 1998; Peele, 1985; Pomerleau & Pomerleau, 1989). They have rejected an overtly biological reductionist approach in favour of a model that considers the subjective nature of addiction to be important. This has resulted widening of the term whereby many other behaviours are considered addictive. A working definition is provided below:

> 'Addiction is the repeated use of a substance and/or a compelling involvement in a behaviour that directly or indirectly modifies the internal milieu (as indicated in changes in neuronal activity) in such a way as to produce immediate reinforcement, but whose long term effects are personally or medically harmful or highly disadvantageous societally' (Pomerleau, 1989, p.120).

In this framework physical activity such as running, skydiving, rock climbing and surfing may be considered to be addictive. This is because they may have the ability to produce reinforcing changes in behaviour through neural level effects. In short, any behaviour that modulates reward and punishment systems in the brain and exhibits reinforcing properties can be thought of as addictive. This biobehavioural perspective has been applied to a range of behaviours or habits (Pomerleau & Pomerleau, 1989).

1.4 From 'habit' to 'addiction'

Having considered a theoretical model of addiction it is interesting to assess the anti-addiction views of smoking prevalent thirty or more years ago. In 1964, the advisory committee of the U.S. Surgeon General on Smoking and Health (Service, 1964) stated that smoking was a habit not an addiction. This conclusion was based on the then current World Health Service definition of addiction which stated that: 'addiction is a state characterised by need or compulsion to use a drug, a tendency to increase the dose, and psychic and physical dependence on the effects of the drug'. The 1964 Surgeon General's Report (SGR) observed that smoking had neither a characteristic abstinence syndrome nor a consistent pattern of cessation. Furthermore, cessation intervention was poor, and the dependence caused by smoking was incomparable to that caused by other drugs such as morphine and barbiturates.

Given that mainstream psychology of the 1960s and 1970s, was dominated by behaviourism and behavioural modification therapy, it is not surprising that psychological theories of that time viewed smoking as a habit and not as an addiction (Hunt, 1970). In habit based formulations smoking was characterised as behaviour influenced by simple learning mechanisms with the main reinforcer being the alleviation of stress or the disengagement of activity. Smoking was seen as equivalent to other habitual behaviours that appeared to reduce tension and alleviate stress. Hunt (1970) suggested that the term addiction should be reserved for:

> "those situations marked by increased bodily tolerance, with the consequent need for an increased dosage, and by the prominence of withdrawal symptoms", (1970, p.67).

Thus the distinction between habit and addiction was made on the basis of the presence or absence of dependence. Where dependence could not be demonstrated Hunt preferred the term habit or habituation. Dependence was not applied to smoking and no general agreement about the distinction between addiction and dependence was made.

Over a period of a decade there was a shift away from the view that smoking is non-addictive. This is highlighted through DSM-III's (American Psychiatric Association, 1980) inclusion of nicotine dependence as a diagnostic category. A subsequent Surgeon General Report came to the conclusion in 1988 that smoking was an addiction and that this addiction should be based on the primary criteria used to define drug dependence. These were: highly controlled or compulsive use, psychoactive effects, and drug-reinforced behaviour. Medical and psychiatric pronouncements forced smoking to be considered as a psychopathology. The current version of the manual, (DSM-IVr) (American Psychiatric Association, 1994) maintains a sub-category of substance use disorder, which includes addiction to nicotine.

If measured by the three factors of tolerance, withdrawal, and craving, then smoking fits the label of an addictive behaviour and displays the features common to all addictive disorders. Smokers exhibit a tolerance for nicotine because although the number of cigarettes smoked does not rise inexorably year on year it does reach a peak quite quickly. Withdrawal is almost always accompanied by craving which is relieved by smoking. Smoking behaviour therefore satisfies the three components specified and qualifies as an addiction. However, smoking in practice does not fit neatly into a narrow model of addiction. It is clear that smokers differ in their smoking behaviour, tolerance, withdrawal, and craving. So a narrow model of smoking behaviour does not explain the variability found between smokers. It also fails to consider the social, cultural, intra- and inter-personal factors that play a role in the initiation, maintenance, and cessation of smoking behaviour. The next section considers models formulated to explain smoking behaviour.

1.5 Nicotine Addiction and Dependence Models

Early nicotine addiction models of smoking evolved in part from the work of (Schachter, 1977;1978) and Jarvik (1973). At this time theorising focused on the pharmacological and physiological effects of nicotine in the development of smoking. This approach offered a narrow interpretation of smoking behaviour and suggested that physical dependency on nicotine was the cardinal factor responsible for addiction to smoking. According to Schachter the development of smoking is driven by the pharmacological need to maintain plasma nicotine at levels which do not precipitate withdrawal. Essentially, smoking is seen as an escape response to nicotine withdrawal. The smoker maintains smoking in order to alleviate withdrawal and to avoid the uncomfortable physiological effects of nicotine deprivation. This formulation implies a linear relationship between exposure to nicotine and the development of a smoking habit. However, it does not account for the wide range of smoking patterns found between smokers and the fact that smokers have numerous and varying motivations that are not pharmacologically defined (Gilbert, 1995).

Evidence to support the proposition that nicotine is a sufficient condition for smoking has been inconclusive. It has been shown that pre-loading smokers with nicotine does not reduce subsequent smoking, (Kozlowski, 1975; Kumar, 1977; Lucchessi, 1967). Furthermore, although administering a nicotine antagonist increases smoking rate (Stolerman, 1973) alternative protocols have failed to find a dose-response effect in smoking following an intravenous administration of nicotine (Kumar, 1977). However, there is evidence from animal and human studies that supports nicotine's strong reinforcing effects and shows that it is the primary psychoactive substance in the development and maintenance of smoking (Ney & Gale, 1989). Therefore, it is clear that nicotine exerts powerful reward, punishment, and arousal effects (Ney &Gale, 1989). Clearly nicotine has a significant impact on the brain and optimum effects are achieved through the smoking of tobacco. However, theories which see smoking as simply an addiction to nicotine (or as primarily a nicotine reinforced behaviour) are too narrow in their descriptive and explanatory scope. This review shows that smoking is a multifaceted behaviour. Dependence on nicotine alone does not determine the onset maintenance or cessation of smoking behaviour.

A simple nicotine addiction model is not able to explain why some individuals are able to smoke without a gradual increase in dosage and others are able to smoke at will without deleterious effects following cessation. Indeed, some smokers ('chippers') are able to continue smoking at low levels and with inconsistent patterns (Shiffman, 1990). It has been suggested that these individuals may be protected against reinforcement by a nicotine metabolism defect, (Pianezza, 1998). Finally, many smoke in situations that are not characterised by either a need for nicotine or the avoidance of withdrawal effects. They seem to smoke in response to stimuli that are independent of the nicotine-addiction cycle. For example, during a stressful examination, after a meal, after sex, with a drink, or when required to concentrate. *Ad libitum* smoking has been shown to be prompted by certain interoceptive and exteroceptive stimuli which are independent of the time since the last cigarette (Gilbert, 1995; see also Ney & Gale, 1989). Thus, smoking does not always occur under conditions of craving or need for an increase in plasma nicotine levels. It frequently occurs when an individual perceives a need for affect modulation or thinks that smoking may benefit cognitive performance by improving attention or concentration. Moreover, nicotine replacement does not always obviate craving, and relapse may occur many weeks or months after the physiological dependence on nicotine has disappeared (Shiffman, 1982;1986). In summary, the addiction model is therefore unable to explain long term relapse, many observed individual differences in smoking behaviour, and the interrelationship between individual factors and socio-environmental factors.

1.6 Learning models of smoking

A person who smokes an average of 20 cigarettes per day will have smoked approximately seventy three thousand cigarettes (over a ten year period). This involves over 700,000 individual puffs or drags. Each microboli of nicotine from each puff delivers a reinforcing effect to the reward and punishment system of the smoker's brain. Each cigarette serves as a reinforcer of the behaviour, and each smoking episode is associated with a particular context (internal and external) which may condition future smoking.

Nascent learning models argue that smoking is the cumulative result of chronic exposure to nicotine's primary reinforcing effects. These are addiction models with learning theory added (Wikler, 1973; Wikler, 1984). During episodes of smoking, related stimuli (e.g. environmental and social contexts, smoking tools, such as a lighter or matches, tobacco, rolling papers or the pack of cigarettes) frequently or always accompany the act of smoking. Within a simple learning model it is hypothesised that when stimuli are repeatedly paired or associated with the drug they become conditioned stimuli (CS) which bring about the occurrence of conditioned responses on future occasions. By this process exteroceptive and interoceptive stimuli can become CSs that give rise to CRs and therefore drug seeking and drug taking behaviour.

The above description may be considered an incomplete representation of the learning processes because smoking behaviour may be better described as operant. However, in the context of smoking the two modes of learning are both compatible and reflexive. For example, when a smoker decides to smoke but has no cigarettes at hand, the behaviour of finding a vending machine or corner shop to buy cigarettes is clearly an instance of operant behaviour. The subsequent smoking of the cigarette produces clear and powerful hedonic effects. Cues that are regularly associated with these effects can then become CSs and may drive and effect operant drug seeking behaviour.

1.6.1 The conditioned withdrawal model

A formal learning approach has been proposed by Wikler (1973,1984). Wikler formulated the conditioned withdrawal model to explain opiate addiction. The theory claimed that morphine addiction was reinforced by two factors: the hedonic effects of the drug itself and the amelioration of withdrawal. He suggested that interoceptive stimuli such as affective states could produce neurological changes that are similar to the effects of the addictive drug. These stimuli may then become conditioned stimuli triggering cravings and continued drug use. Many investigations have sought to empirically support this hypothesis. One protocol takes advantage of naturally occurring drug user conditioning histories and compares these with non-conditioned histories. The other protocol directly manipulates conditioning episodes under controlled laboratory circumstances. These are reviewed below.

Kaplan et al. (1985) investigated physiological reactions and self-reports of desire to drink in hospitalised alcoholics and non-problem drinkers. Participants were presented with their favourite beverage and allowed to hold the bottle and sniff the contents, the control stimulus was cedar chips. Psychophysiological measures revealed significant group differences, with the alcoholics showing increased heart rates during exposure to alcohol, while desire to drink ratings did not differ between alcoholics and non-problem drinkers. Both groups reported an increased desire to drink following alcohol exposure. However, further analysis revealed that for the alcoholic group desire to drink was positively correlated with physiological reactivity to the alcohol stimulus. The authors concluded that this evidence supports the multidimensional nature of craving and the relationship between conditioned responses to drug cues and craving. Further support for the conditioned withdrawal model is provided by Powell (1993) who presented opiate addicts with pictures of individuals injecting the drug, drug-related equipment, and cartoon slides as a control. The findings revealed that addicts had higher levels of craving when drug-related cues were present than when control cues were presented. Dysphoric states and withdrawal like symptomatology were also reported in the drug cue conditions, suggesting that drug-cues may elicit cravings and influence affective states.

Finally, Droungas (1995) studied the effect of smoking cues and cigarette availability on craving and smoking behaviour. Smoking cues were presented in a video showing the actors smoking in various contexts, (e.g. when eating or waiting for a bus). A wildlife documentary was shown as the control stimulus, and an unpleasant condition was provided by a video of accidents in a saw mill. Smokers were allocated to 'smoking' or 'no smoking' conditions prior to exposure to the three cue conditions. The 'smoking' group were allowed to smoke in a post session waiting room where cigarettes were provided, and the abstinence group had a tray of sweets provided. Thus, smokers either expected to be able to smoke after their laboratory session or did not. Those participants who were allowed to smoke in the waiting room were filmed and the amount of time taken to light up a cigarette was recorded. The results supported the hypothesis that participants in the 'smoking' group reported greater cravings to the smoke cues than to the neutral cues. Furthermore, latency to start smoking was shorter in the smoking cue condition than in the control cue condition. This is consistent with findings in other studies, (Niaura, 1989,1992; Tiffany and Hakenewerth, 1991).

1.6.2 Siegel's conditioned opponent process model

Siegel (1975,1989) offered a similar learning model which hypothesized that drug taking was driven by negative reinforcement through which conditioned responses to drug cues modulate drug taking. Siegel proposed that withdrawal like effects are produced by the presentation of cues associated with administration of drugs. Essentially, Siegel contends that CRs are compensatory and opposite in direction to the direct effects of the drug. Tiffany (1995b) and Glautier and Remington (1995) have reviewed the evidence for and against the conditioned withdrawal model and the compensatory response model and argued that the evidence supporting either model is contradictory and inconclusive and highlight certain deficiencies in the models and suggests that specific aspects, such as the form of the conditioned response to drug cues which can varied and be measured by a myriad of measures, are central to achieving a more definitive theoretical position. In the context of drug use the form of the CR is critical, and Glautier poses the question of whether the standard accounts of CR form would be better supported if data from physiological, behavioural and subjective domains were considered separately or were combined. He concludes that either approach would not bring about uniformity in the data and suggests that these theories are not supported by any single protocol. He also states that a single theory of response form could not be successful. However, he suggests that research efforts should continue on pragmatic grounds. He advocates a rigorous experimental approach which is cognisant of factors influencing drug taking and considers drug seeking behaviour to be 'the most direct assay of the motivational effects of cue exposure' (Glautier & Remington, 1995, p.43).

Glautier's pragmatic approach suggests that information from disciplines using different measures and techniques may be helpful in bringing fresh evidence to bear on the role of drug cues in drug behaviour. For example, evidence that drug cues are related to craving and withdrawal has been provided through advances in brain imaging techniques (Grant, 1996). Positron Emission Tomography has allowed researchers to identify specific brain activity linked to the experience of craving. For example, Grant (1996) found that cocaine-related cues in cocaine users increased glucose metabolism in brain regions responsible for memory functions. These findings suggest that memory processes are involved in drug use. Such findings add support to the notion that drug-related cues are involved in ongoing drug use, and are related to craving and withdrawal.

1.6.3 Summary of learning models

The learning models presented above suggest that smoking is controlled by its consequences. For a smoker inhalation of cigarette smoke and the effects of nicotine may be positively reinforced by stimulation of reward regions in the brain. This should be viewed in combination with other positive reinforcers (e.g. feelings of social acceptance, increases in self-esteem). It may also be negatively reinforced by the elimination of withdrawal or the perceived relief of anxiety stress or boredom. Tests of the various models have utilised a range of protocols, including physiological data (heart rate, skin temperature, and blood pressure), behavioural data ('wet dog shakes' in rat studies, latency to smoke in humans) and subjective self-reports. As Glautier and Remington (1995) have noted, much of the evidence is contradictory and support for the conditioned withdrawal model or the conditioned opponent process model can only be garnered from a selective review of the findings. Many studies adopt only a few dependent measures, and there is a paucity of data from studies using subjective, physiological and self-report measures. Studying the conditioned response to drugs is not simple. Often the effects of the unconditioned stimulus do not follow simple stimulus-response modes. Such stimuli may elicit responses in multiple and complex interactive systems and the use of unitary dependent measures fail to capture the complexity. Furthermore, the range of stimuli that can be considered capable of becoming CS in drug behaviour are large, and the number of stimuli that may play a role in instances of smoking at any one time may be numerous.

Greeley and Ryan (1995) have argued that (in the majority of cases) applications of learning theory to the study of drug use are *post hoc.* They suggest that explanations of cue elicited drug related effects are enthymemic:

> 'logically incomplete in the sense that one or more (usually several) of the propositions which constitute the "complete" explanation are omitted' (Greeley, 1995, p.120).

Greeley and Ryan (1995) suggest that experiments investigating learning in drug use assume reliable and consistent conditioning histories. However, it is difficult to exert complete control over conditioning histories because participants do not arrive at laboratories as *tabulae rasae.* For example, it is difficult to exert control over the conditioning histories of the smokers in a study of smokers and non-smokers reactions to smoking cues. Some assumptions have to be made concerning conditioning histories even if they are not directly controlled, and differences in conditioning histories within groups are not expected to be significant contributors to variance in the analysis of main or interaction effects. However, despite these arguments, the application of learning theories to drug use has merit.

In particular, an approach known as 'Cue Exposure' has recently been proposed as a new protocol for examining the nature of addiction (Drummond, 1995). The central thrust of this approach is to integrate cue exposure theory into practice and utilise cue exposure therapy as a treatment paradigm in various addictive behaviours; in particular smoking and alcohol. This approach is rooted in classical operant approaches to behaviour. It provides a methodology to test hypotheses of addictive behaviour within controlled procedures. Advocates of the paradigm argue that data will have impact on theory and practice, and will allow for a more precise method of studying the phenomenon of relapse, which is a primary agenda in the field of addictive behaviours.

1.7 Affect regulation models

As early as 1667 it was observed that tobacco was used for a myriad of reasons including helping one sleep and 'expelling evil humours', perhaps reflecting nicotine's affect modulation properties. Von Grimmelshausen (1667, In England, 1996) said,

> One man smokes because it enables him to see better; another because it disperses water in the brain; a third to ease his toothache; a fourth to stop the singing in his ears, a fifth will tell you it *makes him sleep*; a sixth that it quenches his thirst; a seventh that it neutralises the effects of too much water drinking; an eighth that it *expels evil humours*; the ninth man smokes it to pass the time; the tenth because he doesn't wish to be unsociable....(England, 1996, p.108-109, italics added).

With the empirical finding that smoking exhibits anxiolytic effects, and is used by smokers to modulate affect, several affect regulation models have been proposed. In general these models attempt to explain smoking motivation in terms of nicotine's ability to regulate affect and an attempt is made to investigate psychological and physiological mechanisms involved in the relation between affect regulation, nicotine addiction, and smoking cessation. Smoking within this approach is reinforced by a number of mechanisms and is a rejection of the univariate approach characteristic of addiction-dependence models.

1.7.1 Tomkins' Theory

Tomkins was one of the first to offer a model of smoking motivation, derived from a more general theory of affective processes. He hypothesised that innate psychobiological mechanisms are involved in the regulation of affect such that positive affect is reinforced and negative affect is not. Tomkins developed a model of smoking that stated that modulation of affect is the primary factor in smoking maintenance (Tomkins, 1966, cited in Ikard, 1969). On the basis of experimental evidence Tomkins proposed that there are two main types of smokers; positive affect smokers and negative affect smokers. He claimed that positive affect smokers are more in control of their lives and they do not use smoking as a coping tool or an aid to problem solving. In contrast, negative affect smokers smoke in response to various forms of negative affect. Some may smoke in response to specific negative affect situations or to a wider set of situations characterised by negative affect. There are important aspects that further differentiate the negative affect smoker into subtypes. These include; affect type, intensity, density, duration and the probability of successfully coping with future negative affect or stressful situations. Such factors may be important for some smokers but not for others. An exact delineation of these types and subtypes has not been empirically tested, but Ikard (1973) developed a smoking motivation questionnaire to assess the types of smokers that are defined in Tomkins's model. Furthermore, questionnaire studies have found some reliable individual differences with respect to tendencies to smoke for positive or negative affect (Russell, 1974; Shiffman, 1988; Tiffany & Hakenewerth, 1991). The specific structure of measures of smoking motivation have not received much attention in the literature. The factor structure of the 27-item SMQ will be evaluated in Chapter Four and the role of smoking motivation in smokers processing of smoking-related stimuli is investigated in Chapters Six, Seven and Eight.

1.7.2 Solomon's Opponent process theory

Solomon's theory represented an attempt to integrate findings from behavioural and physiological psychology into a model of smoking motivation (Solomon, 1973; Solomon, 1974; Solomon, 1978). There are three basic features of the theory: (1) the smokers reaction to cigarette smoke is biphasic, that is, it is initially pleasurable (a process) but becomes dysphoric (b process); (2) the pleasurable (a process) and the dysphoric (b process) are determined by the sum of the two opponent process at any given time; and (3) paired stimuli can elicit this state as a conditioned response after repeated pairings.

The central hypothesis is that nicotine ingestion gives rise to a positive hedonic reaction, which results in an opponent negative subjective response. With continued use this opponent process and subjective state (conceptualised as craving) becomes the primary reinforcing factor; in that the negative subjective state can be ameliorated by taking nicotine. Therefore, the modulation of affect and the maintenance of an affective equilibrium becomes rewarding in itself and acts as a reinforcement of the drug taking behaviour. Because the model is similar to the nicotine reinforcing and addiction models it is unable to explain wide individual variations in smoking motivation and behaviour. It is also unable to account for the fact that not all smokers smoke to modulate affect or to maintain an affective equilibrium. The theory is not comprehensive enough to describe and explain the variability found in smoking patterns and motivations. Finally, it cannot explain why many smokers experience relapse after the pharmacological effects of nicotine have worn off and the withdrawal symptoms are no longer present (Shiffman, 1989).

1.7.3 The Multiple Regulation Model

Leventhal (1980) proposed a model that places the regulation of emotion at the centre of smoking behaviour. The model was a response to narrow unifactorial addiction models because it contends nicotine regulation in smokers is due to the conditioning of emotional states to nicotine ingestion and regulation, and not due to pharmacological dependency. In this model people smoke to regulate emotional states and to reduce variability in affect. Emotional states which have become conditioned to nicotine regulation can also be influenced by exteroceptive or interoceptive cues. Emotional memory schemas are generated through conditioning which integrates external stimulus cues with internal ones. Furthermore, activation of a memory schema can elicit other aspects or portions of the schema. Thus smoking-related stimuli and their contextual environment act as schema activators bringing about craving and a motivation to smoke. The state of craving and the level of blood plasma nicotine are not directly related. Instead, the individuals idiosyncratic smoking history defines the nature of the relationship between craving and the level of nicotine in the blood.

1.7.4 Summary of the role of affect in smoking

The models described all suggest that affective states play a significant role in smoking behaviour. However, there is no definitive evidence in support of their central tenets. Gilbert and Wesler (1989) examined the evidence concerning the relationship between emotion, anxiety and smoking available in the late 80s. He observed that self-reported responses to stressors depend on the individuals smoking history and the type of stressor employed in the experimental situation. The potency and proximity of the stressful stimulus seems to be an important factor in smoker's responses. All people react differently to stress and anxiety (regardless of whether they are smokers or not) and adapt to stress with a range of behavioural coping strategies. Evidence suggests that nicotine is associated with increases in endorphin levels in the brain that are capable of producing negative or positive reinforcement effects that could be experienced as improvements in affect. There is also evidence that the affect modulating properties of nicotine are dose dependent in that smokers titrate nicotine intake is dependent on situational demands (Gilbert, 1989).

Shiffman (1986) has demonstrated that affective states play an important role in relapse because stress or episodes of negative affect are the most frequently reported precipitants of relapse. Moreover, affective pressure related to social smoking stimuli (e.g. being in the company of other smokers) were prominent preconditions for relapse. Studies of relapse factors therefore suggest that neither positive nor negative situations, *per se*, determine relapse, rather it depends on the individuals circumstances and idiosyncratic reactions to daily life events (Shiffman 1986). Further support for the role of stress and negative affect in smoking relapse is provided by other researchers (Pomerleau, 1978; O'Connell, 1987, 1988; Cohen, 1990; & Brandon, 1990). Their findings have important implications for an understanding of not only the conditions or factors that are involved in smoking relapse, but also individual differences in smoking behaviour. Evidence also supports the argument that smoking can modify pain perception (Pomerleau, Turk & Fertig, 1984), anxiety and stress (Dobbs, 1981), but not phobic anxiety (Fleming, 1987). Furthermore, the antidepressant effects of nicotine patches have been observed in non-smoking patients with major depression (Salin-Pascual, 1996) and comorbidity between depression and smoking has been reported in adolescents (Fergusson, 1996).

Parrott (1995) investigated the relationship between smoking and stress in studies monitoring smoking and mood over a day of smoking (O'Neill & Parrott, 1992; Parrott 1993a; Parrott & Joyce, 1993; Parrott, 1994abc). In the series of studies reported by Parrott (1995) participants were required to smoke a minimum of four cigarettes in the day, and mood ratings were obtained via a 'brief feeling state questionnaire' derived from the Short Adjective Check List (Mackay et al., 1978, cited in Parrott, 1995). Subgroups of smokers were selected through the Smoking Motivation Questionnaire (SMQ) (West and Russell, 1985). Participants were classified as 'sedative' smokers or 'stimulant' smokers according to their SMQ sub-scale scores for the first three studies, and in the final study participants were grouped across the whole range of the sedative sub-scale. Results of the fourth study (Parrott, 1994ab) showed that smokers mood improved after smoking. This benefit did not last the whole inter cigarette interval as smokers experienced mood deterioration between cigarettes. With regards to individual differences in stress/smoking patterns the SMQ sedative sub-scale classifications were not successful in the first three studies reported (O'Neill & Parrott, 1992; Parrott,1993; Parrott & Joyce, 1993), sedative and stimulant smokers did not have differential mood profiles. In the fourth study (Parrott, 1994ab) only the sedative sub-scale was used to index relationships between individual differences and stress differences pre-post smoking. The results suggested a linear relationship between self-reported stress and the sedative sub-scale of the SMQ. Most notable was the finding that smokers who scored lowest on the sedative sub-scale experienced the least stress change in response to smoking. In contrast high scoring sedative smokers experienced the greatest post-smoking increase from pre-smoking levels. This result both confirms the validity and utility of the SMQ in studies of affect and smoking and supports the hypothesis that the stress-smoking relationship is dependent on smoker's individual differences and self-reported motivations to smoke. Further examination of this relationship revealed that mood was not improved for smokers relative to non-smokers, suggesting that smoking does not seem to give smokers a net mood benefit. In conclusion, the findings from the four studies presented by Parrott (1995) suggest that smokers smoke not only to avoid withdrawal, but also to deal with stresses in the environment.

Gilbert (1995) reviewed laboratory studies of affect modulation by smoking and concluded that although nicotine does attenuate negative affect its effects are not constant over all situations. As previous reviews and studies have shown nicotine's effects are conditional (Pomerleau & Pomerleau, 1991; Carmody 1992ab; Gilbert & Welser, 1995; Parrott, 1995). Gilbert (1995) makes an important recommendation in his conclusions concerning the investigation of abstinence and mood changes during abstinence. He suggests that there is a paucity of data concerning abstinence-related increases in negative affect. That it is not clear what effects abstinence may have on certain moods, what stimuli may be important during periods of abstinence, and how the smoker processes such stimuli, (Gilbert, 1995).

In conclusion, the central question that all affect regulation models address is does nicotine have inherent stress reducing properties independent of the nicotine withdrawal cycle and the relief of nicotine withdrawal. Evidence so far suggests that nicotine's effects are not independent because many situational and individual factors interact with the biological effects of nicotine to bring about the affect modulation properties that smokers report as a strong motivation to smoke. On a methodological point, self-reports of affective states, behavioural measures and physiological responses do not correlate very highly. Therefore, if a range of measures are used as indices of affect in a study, and they are not strongly correlated, then it would be hard to reach tenable conclusions regarding smoking's effect on stress or anxiety. Moreover, emotion, mood, stress and anxiety are frequently used terms found in studies of the smoking-affect relationship. It is assumed that that they are interchangeable and relate to the same construct. However, there is no general agreement as to what emotion is (O'Rorke, 1994; Ortony, 1990; Ortony, 1994; Strongman, 1996). The use of varied and sometimes unreliable and poorly constructed indices of mood, affect, stress or anxiety is a clear methodological flaw in much of the studies conducted with the exception of a few, e.g. (Parrott, 1995; Gilbert, 1995). Gilbert made this point very well when he stated; 'Smoking research and clinical efforts have been impeded by a failure to differentiate between affective processes.....it is rare to find affect-related processes differentiated in the smoking literature' (Gilbert, 1995, p.39).

1.8 The Biobehavioural Model

Pomerleau and Pomerleau (1984,1988,1989) suggested a multifaceted approach to addiction. This model incorporates principles of classical and social learning theory, aspects of affect regulation models, and biological factors into a biobehavioural approach to abuse and addiction. The model is premised on the condition that any adequate elucidation of the mechanisms which control smoking needs to garner and integrate evidence from the behavioural, physiological and cognitive factors involved in smoking behaviour. According to the biobehavioural approach smoking is first acquired under conditions of social reinforcement. The novice smoker finds the first cigarette aversive and unpleasant but the social reinforcement accompanying smoking increases the likelihood that the smoker will continue. Eventually tolerance to the aversive effects of smoking develops and the behaviour begins to produce positive reinforcement which is independent of social reinforcement. As smoking continues in a variety of social contexts (some favourable to smoking and some not) these become controlling factors. An associative relationship is then reinforced involving interoceptive and exteroceptive cues and episodes of smoking behaviour. Therefore, by association with smoking certain stimuli become conditional stimuli capable of eliciting craving and smoking behaviour. Moreover, exteroceptive and interoceptive stimuli (and combinations of the two) can provide occasion for the reinforcement of smoking by becoming discriminative stimuli (SDs). These secondary reinforcing stimuli reinforce behaviours associated with the preparation and the actual smoking itself.

1.8.1 Gilbert's Situation by Trait Adaptive Response (STAR) model

Gilbert (1995) has proposed a biopsychosocial model of smoking behaviour addresses the multivariate nature of smoking behaviour. Gilbert claims his theory is broad enough to integrate the biological, psychological and environmental factors involved in smoking. The model is derived from observations in a wide variety of investigations of smoking behaviour. This data indicates that smoking is influenced or reinforced by a variety of factors which are situation specific and interactive with personality and trait adaptive responses. The STAR model is a comprehensive theory and incorporates situational factors such as affect, with trait and motivation factors. It recognises that each smoker has an individual relationship with cigarettes and that the multiple reinforcing effects of nicotine are represented in many different ways. Each smoker has his/her own smoking history and trait and situational factors interact in each smoker in different ways. A more detailed account of the extensive and complex STAR model is beyond the scope of this section. However, one important aspect of the STAR model is the situational component. Gilbert (1995) suggests that smoking is highly sensitive to situational contingencies and that stress nicotine and abstinence cues feed into trait factors which drive smoking behaviour.

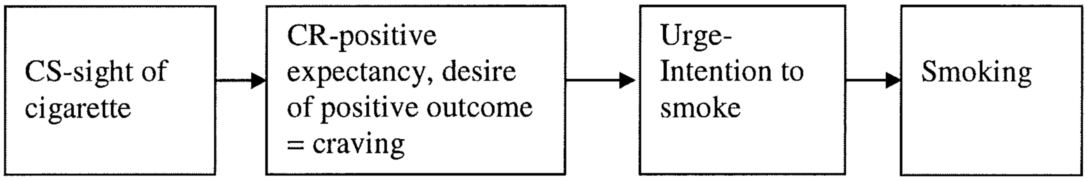
1.9 Cognitive models of Addiction

Traditional cognitive themes such as knowledge, beliefs, expectations and attitudes have been linked to addictive behaviours. It is believed that such factors are important to the initiation, maintenance and the cessation of smoking. There are two main schools of cognitive psychology that can be applied to the study of smoking behaviour. The first is the cognitive paradigm, which uses self-report measures to describe decision making and develops cognitive behavioural models of how individuals cognitive processes bring about behavioural change or action. The second is the information processing neuro-cognitive approach that relies on response measures such as reaction times and other objective behaviours as indices of cognitive events. By and large self-reports have focused on addictive behaviours and response measures have been used in the study of the initiation, maintenance, cessation and relapse of smoking.

1.9.1 Marlatt and Gordon's Model

Foremost in the cognitive behavioural approach is the work of Marlatt and Gordon (Marlatt, 1979;1985). They have developed a comprehensive socio-cognitive model of addiction that focuses on smoking cessation and relapse prevention (Marlatt, 1988). In an early description of the model Marlatt (1979) highlights the importance of understanding recidivism and relapse process in drug use as an avenue to improving knowledge of maintenance and effective interventions. Marlatt's work on the cognitive aspects of smoking started with a study of conditioning procedures in alcoholics. He observed that interpersonal factors were significant determinants of relapse (Marlatt, 1973; cited in Marlatt, 1979). Subsequent detailed analysis using data from a sample of smokers, heroin addicts and alcoholics revealed that both intrapersonal and interpersonal factors were determinants of relapse. Marlatt observed that 76% of relapse episodes fell into three categories: coping with negative emotions, social pressure, and coping with interpersonal conflict. For the smoking group negative emotional states accounted for 43% of the intrapersonal factors, suggesting that when abstinent smokers relapse it is mostly in response to stress. These observations led Marlatt and Gordon (1985) to focus on the interactive contributions of self-efficacy, outcome expectancies, and attributions of causality in determining relapse (Marlatt, 1985). Marlatt suggested that these three factors play a crucial role in the relapse process. Marlatt (1985) also makes specific observations concerning the role of smoking cues in the maintenance of drug taking and emphasises their role in the production of urges. Such cues are important variables in smoking behaviour as exemplified in the positive expectancy model presented in Figure 1.1. In this model, the sight and smell or any other smoking-related conditioned stimulus elicits a craving response and an associated positive expectancy in the smoker. This state is then translated into an intention to use cigarettes or an urge to smoke which eventually leads to actual smoking.

Figure 1.1; Schematic model of Marlatt's positive expectancy model of cue reactivity (adapted from Marlatt, 1985) (CS = conditioned stimulus; CR = conditioned response).



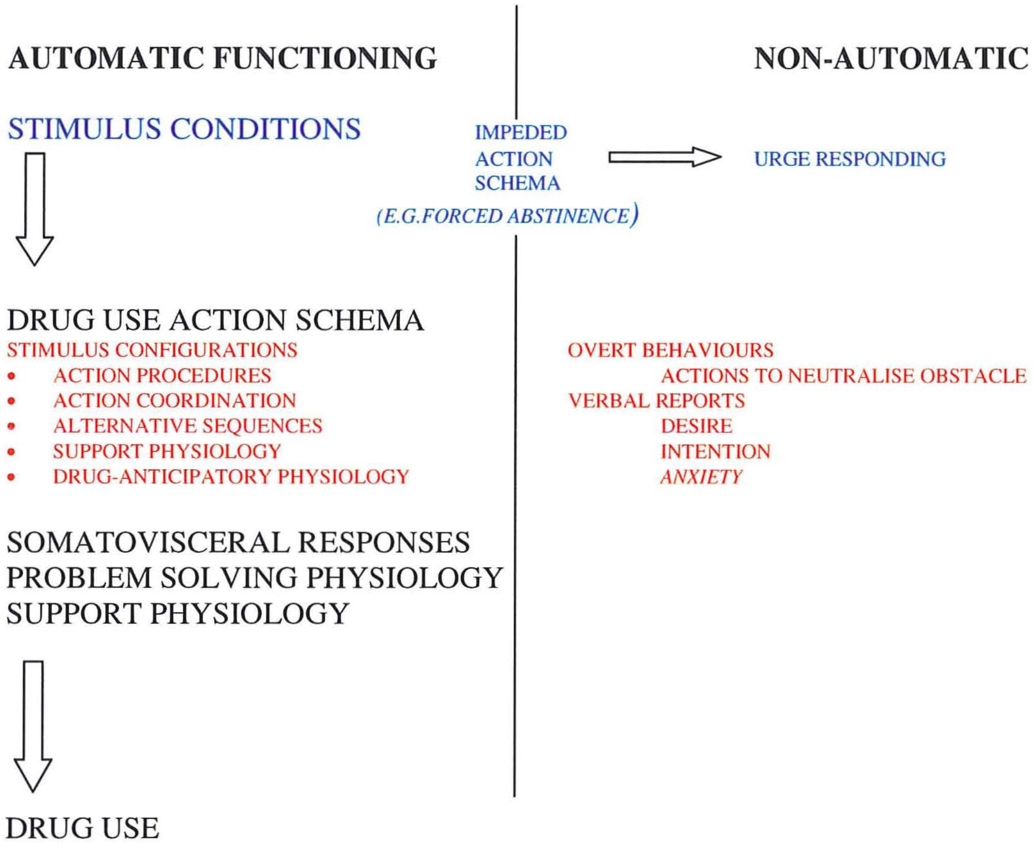
The model argues that expectancy has informational and motivational components. Smokers have knowledge about what will happen when they smoke. They also believe that the effects of smoking are experienced as desirable even though this may not actually be true. As Marlatt (1985) states 'The expectations one holds about the effects (perceived outcome) often exert a greater influence than the actual or "real" effects of taking a drug', (Marlatt, 1985, p.137). As Figure 1.1 shows, the presentation of a drug paired smoking-related stimulus to a smoker brings about an expectancy reaction. That is, an expectation that smoking will bring about a desired effect. This expectation and desire to experience the effects of smoking generates a conditioned response that is characterised as a craving. Urges are seen by Marlatt as the intention to use. These generate the actual behaviour and in turn the reinforcement of the behaviour, so that whenever such stimuli present themselves to the smoker in the future, if the stimulus and environmental conditions are correct s/he will smoke. It is important to note here that Marlatt's descriptions of drug users responses to drug cues are different from Wikler's conditioned withdrawal model (Wikler, 1973). In Wikler's model, craving states are aversive and driven by the need to avoid or alleviate withdrawal. In Marlatt's model positive expectancies are generated by conditioned responses which are appetitive or positive (Marlatt, 1985). Thus, Marlatt's model is based on a fundamentally different principle, and can account for long term relapse (which Wikler's model cannot) because it is unlikely that physiological withdrawal is a precipitator of long term relapse.

1.9.2 Tiffany's Cognitive Processing Model

Tiffany's model proposes that smoking-related stimuli are part of the urge response and automatic drug action plan in smoking behaviour (Tiffany, 1990). Tiffany presents an alternative model of smoking which rejects the argument that craving and urges are central to drug use behaviour. The central theme of the model is the notion of automaticity. Tiffany argues that repeated practice of a cognitive task leads to the development of a skilled behaviour that becomes automatic. The repetition of smoking-related behaviours and associated cognitive tasks leads to a situation where anteceding smoking behaviours are so skilled and practised that they become automatic; in the same way as behaviours associated with driving a car become so practised that they no longer exhibit conscious control. Tiffany therefore characterises drug-taking behaviour as having both automatic and non-automatic cognitive server systems. A schematic representation of the model is provided in Figure 1.2.

The left-hand side of Figure 1.2 depicts the sequence of events that occur during a drug use episode. The stimulus conditions that activate the drug use schema (or drug use action plan) are varied and specific to a particular smoker. They are laid down as memory systems related to drug use actions and plans. Therefore in a typical drug use episode the model does not include cravings or urges in the process of drug use. Instead, cravings and urges are considered to be constellations of responses elicited by the impediment of the drug use actions schema, as depicted on the right hand side of Figure 1.2. From the present authors own experience of smoking and through observations of smokers in 'normal' settings, social gatherings, bus stations, in the pub and the like, it is immediately obvious that smoking is very automatic and smoking rituals are practised and fluent. If a smoker is asked the question "why are you smoking that cigarette?" they may not be able to answer the question, because they are unaware of the actions preceding smoking. Smokers may be able to describe what they are doing but not how they do it (e.g. "I know I am smoking now, but I can't tell you why I am smoking now, I just fancied one"). Non automatic smoking by contrast is slow, effortful and dependent on intention and attention.

Figure 1.2 Tiffany's Cognitive processing model (adapted from Tiffany, 1995).[2]



Smoking seems to be amenable to the development of automaticity because research suggests that automaticity develops rapidly when stimulus conditions are constantly and uniquely associated with response (Shiffrin & Schneider, 1977, cited in Tiffany, 1990). Thus, according to Tiffany (1990) drug taking behaviours are fast and efficient, enabled by particular stimulus conditions, difficult to stop in the presence of triggering stimuli and initiated and completed without intention.

In conclusion, Tiffany suggests that cognitive processes that subserve drug-use behaviour are separate from those that serve urges and cravings. The model therefore asserts that systems responsible for linking drug-related stimuli to drug use behaviour operate independently of the processes that control craving (Tiffany, 1990; Tiffany, 1995b). Several predictions

[2] The items in italics have been added, they were not included in Tiffany's (1995) description of the model. Abstinence can be considered to be a situation in which action schema or normal drug use action plans are impeded and give rise to non-automatic functioning. Anxiety could also be considered to be a consequence of a frustrated drug action plan and could be indexed by verbal report.

emerge from the model. It predicts that urge responding should be associated with interference on concurrent tasks that require non-automatic processing for their successful completion. Moreover, ongoing drug taking behaviour should not impact on concurrent tasks as this behaviour is relatively automated and therefore demands less cognitive processing. In addition, Tiffany also proposes that when a smoker is trying to maintain abstinence non-automatic processing will be activated to prevent the completion of the drug-use action plan. As a result the activation of automatic or non-automatic processing will give rise to different patterns of responses in verbal, behavioural and physiological domains. These predictions have received scant attention in the literature.

However, some of Tiffany's own work attempts to address the nature of urge responses in relation to abstinence and affect through the use of imagery (Tiffany & Hakenewerth, 1991; Maude-Griffin & Tiffany, 1996). These studies have provided some support for Tiffany's assertion that urges are part of a non-automatic processing reaction to impeded drug action plans. Others have examined Tiffany's claims that non-automatic processing and associated urges should bring about deleterious effects on an associated cognitive task, (see Tiffany, 1990). For example Zwaan and Truitt (1998) examined the effect of smoking urges on language processing in smokers and found that an imagery manipulation successfully elicited urges to smoke which caused a significant reduction in their performance on a language comprehension test.

In summary, the principal cognitive models reviewed in this section contend that consideration of cognitive factors is crucial in any endeavour to understand and explain drug taking behaviour. Marlatt and Gordon's (1985) model describes a model of relapse prevention, focusing on concepts of self–efficacy, positive expectancy and attribution. The expectancy model prescribes a role to smoking-related stimuli in the development of craving, urges or intentions to smoke. Tiffany's model (Tiffany, 1990) incorporates behavioural, cognitive, and physiological factors within a comprehensive and challenging cognitive processing account of smoking behaviour. Finally, Gilbert's STAR model of smoking behaviour provides a good example of an interactional and multifactorial model that pushes at the theoretical boundaries that have constrained theoretical developments in smoking research.

1.10 Models of attention and attentional bias

The previous sections reviewed the principal cognitive models of addiction and outlined the contribution of these models to understanding smoking behaviour. In order to contextualise the research tools employed in the present thesis it is also necessary to provide a short review of cognitive models of attention and attentional bias relevant to the present thesis.

Cognitive psychology seeks to understand human behaviour by recourse to models that describe the architecture and functioning of an individuals internal cognitive environment. Therefore, cognitive psychology seeks to explain human behaviour by conceptualising human beings as information processors, and posits the existence of various internal cognitive architectures that operate on the perception, encoding and retrieval of information. A cardinal issue for cognitive psychology has been the concept of attention. A conclusive description of attention remains to be provided, however, a working definition has been offered by Wells and Mathews (1994) who state that attention can be loosely defined as 'the selection or prioritisation for processing of certain categories of information' (Wells & Mathews, 1994, p10). However, they qualify this statement by pointing out that theoretical considerations of the concept of selection will determine the use of attention as an explanatory concept. Despite this caveat much research has been conducted with the intention of describing and delineating attentional processes. One useful distinction that can be made is between selection and intensive processing. Firstly, the attentional system has to select which inputs are to be extensively processed and secondly which are fed into control and action responses. All this going on in a system which requires fast and efficient processing within a limited resource envelope. The issue of selective and intensive aspects of attention has been central to much of the work conducted on attention, and many theories have attempted to describe the specific architecture and functioning of various circuits related to selective and intensive processing at the attentional level. The issue of selective attention is also germane to the present thesis, and it is this particular aspect of attention that will be the focus of what follows.

Early theories of attention focused on the issue of selection by arguing that selection either occurs early or late. Broadbent (1958) proposed that selection occurs at an early stage of processing, which is achieved by a selective filter that determines which inputs are bound for intensive processing and those that are not. However, work on dichotic listening tasks and shadowing tasks have demonstrated findings inconsistent with this model. Triesman (1960, cited in Wells & Mathews 1994) has demonstrated that when individuals are given a task which requires listening to different inputs though each ear they are able to track a message that switches from one ear to another, which suggests that attended and unattended messages are processed and analysed semantically. According to more contemporary selection theories the first stage of selection involves stimulus driven analysis, with a second stage involving more top down processing. This is where analysis of inputs is affected by individual expectations and memories, and as we will be discussed shortly, emotional disorder and motivational state may also modify attentional processing.

Another significant issue that bears on attentional processing is the issue of automaticity. It is apparent from observation and individual experience that it is possible to perform one task while attending to another. For instance it is possible to drive a car- a complex behaviour- and carry on a conversation with a passenger, and listen to the radio at the same time. This suggests that certain complex behaviours can become automatic and make relatively little demands on attentional processing. It possible to propose that two levels of attention exist. One level characterised by deliberate and controlled processing, and the other by automatic processing which makes fewer capacity demands and is effortless (Schneider, Dumais & Shiffrin, 1984). Findings from studies conducted by Shiffrin and Schneider have supported the distinction between controlled and automatic processing. Indeed, the notion of automaticity in attention and behaviour is a central theme in Tiffany's cognitive model of addiction behaviour reviewed earlier in this chapter. In this theory drug seeking behaviour is automatised over years of use. Drug seeking behaviour becomes effortless, automatic and makes little demand on attention, until drug use behaviour is frustrated, which leads to the experience of drug urges and cravings.

In the late 1970s and early 1980s investigators became interested in understanding cognitive processes and structures involved in emotional disorders. The starting point for this investigation was the important work of Beck (1979) who provided one of the first cognitive models of emotional disorder and provided the foundations for the development of the cognitive approach to emotion. Beck proposed that emotional disorder was characterised by the existence of 'schema' which influence the perception, encoding and retrieval of stimuli in the environment. Beck proposed that schemas were implicated in the aetiology and development of emotional disorders. This theory represented a significant shift in thinking and an important starting point for the development of the cognitive/information processing approach to emotional disorder. In Becks model anxiety and depression reflect the actions of different schema, and in general anxiety schema are related to vulnerability and danger, and depression schemas are about loss, and negative views of self, the world and the future. Beck's model represents the beginnings of the information processing approach and the starting point for subsequent cognitive models of emotion.

One important aspect of the Beck model is the notion that schemas affect the perception of stimuli in the environment, and the model predicts that anxious individuals will demonstrate biases in attention towards threat-related stimuli. This hypothesis has been investigated by contemporary investigators who have sought to elucidate the role of attentional processes in general anxiety disorder, (Mathews, 1990; Mathews, 1993) phobias (Watts, 1986; Ost, 1992; Lavy, 1993) and depression (Mogg, 1993; Dalgleish, 1990). These theorists describe emotional disorders as being associated with biased processing of self-referent stimuli and argue that such biases are instrumental in the etiology, and maintenance of emotional disorders. The main tenet of their thesis is that attentional bias serves the purpose of directing attention to stimuli that have self-referent significance, and that bias in attention occurs at early stages in processing. In the early stages of attentional processing a stimulus is assessed but its perceptual characteristics are not fully determined. In the clinically anxious individual attention is focused on anxiety-related material, but the non-anxious person does not attend to such material. This difference in attentional processing leads to divergent consequences for the anxious and the non-anxious. Because anxious individuals have a predisposition to focus on threat, their cognitive system tends towards further elaboration and processing of threat material. In contrast the non-anxious person does not show a processing bias for threat material and avoids elaborate processing of threat-relates stimuli.

This work is relevant to the present thesis in several important ways. Firstly, the present thesis applies an information processing approach to the study of smoking behaviour and draws on accounts of cognitive and attentional bias in emotional disorders provided by Williams, Mathews and McLeod (1996). As Mogg, Bradley, Hyare and Lee (1998) have observed it would be useful to explore the hypothesis that cognitive biases may not be unique to psychopathology. It is a viable hypothesis that motivational states such as smoking may be characterised by cognitive and attentional biases, especially under conditions of abstinence, which create craving and withdrawal states. It is the intention of this thesis to explore this hypothesis by the integration of models of attentional bias in anxiety and cognitive models of smoking behaviour and the systematic use of attentional measures used in investigations of anxiety, namely the emotional Stroop and the Dot Probe task. Uses of the Stroop task and the Dot Probe task in smoking research will be discussed more fully in Chapter three.

1.11 Summary

The objective of this chapter was to present a selective review of models of smoking, and to provide a brief review of models of attention in order to contextualise the research tools to be used in the present thesis. It is evident that debates concerning the true nature of addiction are far from resolved. The use of the term is now ubiquitous and it is frequently applied to situations in which there is no ingested pharmacological agent involved in the behaviour called addictive. When considering smoking behaviour it is safe to say that smoking is an addiction. However, nicotine is not the only reinforcing agent involved in smoking. Nicotine ingestion interacts with systems at the neurological level concerned with reward and punishment, as well with cognitive systems involved with attention and performance. A definitive theory that satisfies Peeles' (1985) definition and sufficiently explains such multifaceted behaviour remains elusive.

Narrow nicotine based models, which view nicotine as the primary reinforcing agent involved in the maintenance and cessation of smoking, have been shown to be inadequate. They singly fail to consider secondary reinforcers within their formulations. Although classical learning models also have limited explanatory scope their application to smoking behaviour theory is an avenue of research yet to be fully explored.

The various affect regulation models described offer a good starting point for the investigation of the role of affect and conditioning in smoking behaviour. The notion that memory schemas and smoking-related stimuli are chief factors in smoking behaviour is central to this thesis. The experimental work presented in following chapters focuses on the role of smoking-related stimuli, and the effects of abstinence that brings about craving on smokers processing of smoking-related stimuli. Therefore, of direct relevance is the theoretical position put forward by Tiffany (1990). The theory stresses the importance of considering smoking-related stimuli as factors in smoking within a well-researched and robust cognitive framework that impacts on the initiation, maintenance and cessation of smoking. Therefore, Tiffany provides a working model from which several testable predictions concerning the effects of abstinence on cravings, anxiety, and cognitive bias for smoking words can be derived.

Furthermore, the work of Parrott (1995) provides a rationale for investigating the role of individual differences in smoking motivation in smokers' processing of smoking words. The Smoking Motivation Questionnaire (SMQ) has shown to be a useful predictor in smoking-related research (Parrott, 1995), and so its utility in the present thesis is evident. The use of the SMQ will be reviewed in detail in Chapters Three and Four. Finally, Gilbert (1995) has argued that there is a need for more research to be conducted concerning the effects of abstinence on mood and the relationship between mood change and the processing of smoking-related stimuli. This issue will be examined in more detail in Chapter Three and the exact effects of abstinence on mood studies in forthcoming experimental chapters.

In summary, the present thesis will examine several issues in relation to the key models reviewed above. These include: the effect of abstinence on the processing of smoking-related stimuli, the effect of abstinence on urge to smoke, the effect of abstinence on anxiety, and finally, the relationship between urge to smoke, anxiety, smoking motivation, individual demographic factors (e.g. number of years smoked) and the processing of smoking-related stimuli.

Chapter Two

Smoking-Related Stimuli Used in Investigations of Smoking Behaviour

2. Introduction

In Chapter One it was argued that monistic nicotine based reinforcement theories are not effective in accounting for all smoking motivation behaviours. Moreover, pure classical and operant learning theories are neither sophisticated enough nor use sufficient controls to predict smoking behaviour. Theories that integrate findings from various paradigms (including learning models) into an overall framework for research into smoking should be a focus of continued work. Gilbert's STAR model (Gilbert, 1995) and Tiffany's cognitive model of smoking behaviour (Tiffany, 1990) are good examples. Both consider that smoking-related stimuli play in the initiation, maintenance and cessation of smoking. The present chapter will consider the range of stimuli used in smoking behaviour research. Furthermore, this chapter will outline a context and rationale for a series of experimental studies to be developed in later chapters.

2.1 The sight and smell of cigarettes

For a smoker, the vending machine, the fresh pack of twenty, the box of matches, the lighter and the smell of tobacco smoke may all be considered potent cues to smoke. Exposure to these kind of stimuli has been shown to influence smoking behaviour, physiological reactions, and feelings of urges or desire to smoke (Droungas, 1995; Sayette, 1994; Payne, 1991; Payne, 1996; Abrams, 1988). For example Payne, Schare, Levis, and Colletti, (1991) studied the desire to smoke following exposure to smoking-relevant cues. In this study sixty smokers were assigned to one of six groups. The three levels of the first factor were designed to induce varying levels of negative affect. In condition one (escape) participants were asked to take part in a noise escape task and told that they could not smoke because it would have a deleterious effect on their reaction to the task. To escape from a 3000 Hz, 90dB tone the participants had to press four keys in the correct sequence. Correct answers resulted in the word 'right' being presented on a video screen in front of the participant, and incorrect sequences resulted in the word 'wrong' being presented. Escape from the noise trials was made possible by pressing an escape button that would terminate the tone with no penalty to the participant. In the next condition (non-escape), participants were given the same instructions and the same task but in this condition neither a solution was possible, nor an escape permitted. A yoking procedure ensured that participants in the non-escape condition received the same duration of tone as the escape participants. The final condition (noise only) involved participants attending to the video screen and receiving a series of escape yoked noise trials. The second factor in the design was the manipulation of smoking-related cues. Fifty percent of the participants were allocated to a high salience condition in which the participant was exposed to various objects such as ashtrays, cigarette packs, matches and the smell of smoke. The other half of the participants were not exposed to such objects in the testing room, although they knew that their own cigarettes and matches were behind the video monitor in the room they were being tested in. Dependent variables used to investigate the interaction between cue salience and negative affect induction were smoking typography (puff rate, number of puffs, and mean puff interval), derived from a video tape of the experimental sessions, self-reported ratings of desire to smoke, and state of affect using 7-point Likert scales.

The results broadly confirmed the hypotheses tested. Negative affect and exposure to smoking-related stimuli produced significant changes in desire to smoke and topographical measures of smoking behaviour. Responses in the non-escape group demonstrated that negative affect alone could result in strong urges to smoke. These findings suggest that urge responses may be more related to affective states than to the presence of smoking-related objects. Moreover, further analyses revealed that cues combined with affect resulted in differential urge responses and smoking typography, such that when cue salience was high but there was minimal negative affect, smoking was described as being more automatic. In summary, Payne and his colleagues suggested that although both negative affect and smoking-related objects influence desire to smoke and smoking behaviour affective tone has the greatest impact. These findings concur with an earlier study by Litz, Payne, and Colletti (1987) which concluded that affective states were better elicitors of smoking-related schemata than smoking cues.

In an innovative experiment, Levin, Rose, Behm, and Caskey (1991) investigated the effects of smoking-related sensory cues on psychological stress. This involved delivering refined cigarette smoke condensate to a group of minimally deprived and stressed smokers. Three other groups of smokers received either a nebulized dose of water (placebo), condensate aerosol with fresh smoke from a cigarette, or smoked a Marlboro cigarette. Stress was induced by requiring participants to complete a difficult anagram test, and affect was measured by the Spielberger anxiety questionnaire (Spielberger, Gorush, & Lushene, 1986). The smoke delivery system ensured that the critical experimental group experienced all the sensory aspects of smoking but no significant doses of nicotine, tar and carbon monoxide. The refined smoke condensate therefore allowed for an examination of the ability of the sensory aspects of smoking to bring about a reduction in stress (a confirmed effect of 'normal' smoking), and their role as conditioned or unconditioned smoking cues in smoking satisfaction and craving. The results supported the hypothesis that pharmacologically inactive cigarette smoke reduces anxiety. This finding suggests that the sensory components of smoking are conditioned cues that independently reduce in stress and anxiety. Furthermore, research suggests that sensory cues positively reinforce (when conditioned with the delivery of nicotine, tar and carbon monoxide) the pleasure derived from smoking, (Behm, 1990; Rose, 1987).

In a later study of cue exposure effects Sayette and Hufford (1994) provided evidence of the combined effects of smoking deprivation and cue exposure on self-reported urge and cognitive functioning (as indexed by an associated reaction time task). The main hypothesis was that the urge to smoke is higher in smokers who are both deprived and exposed to smoking cues. Forty smokers were tested in a within groups design, including two experimental sessions with each smoker exposed to smoking and control cues in nicotine-deprived and nicotine-non-deprived states. Smoking cues took the form of the participants holding, lighting, but not smoking their preferred brand of cigarette. The control cue was a roll of tape which participants were told to hold and look at. The reaction time procedure involved smokers being presented with a series of tones and being required to press a mouse button every time they heard a tone.

The procedure for each smoker was as follows. Participants were required to abstain from smoking 12 hours prior to the experimental sessions. At the familiarisation session they completed a questionnaire battery and practised the reaction time task. Following a practice session they were exposed to both the smoking cue described above, and the control cue. Urge to smoke was measured using a ten-point rating scale, which was completed on three occasions during the session, pre-exposure, during exposure, and following exposure.

The results revealed that in the condition where smokers were deprived and exposed to smoking cues, mean ratings of the urge to smoke increased from baseline. The association between reaction time and urge to smoke was also significantly correlated. However, reaction times in deprived and non-deprived groups exposed to smoking cues were not significantly different. Furthermore, it was suggested that order effects (relating to the order in which the smoking cues and neutral cues were delivered) may have interfered with the deprivation manipulation creating a craving state in the non-deprived smokers, thus confounding the interpretation of the deprivation factor in the analysis.

To further explore these confounds and to address the possibility that the observed reaction time effects could be explained by the cigarette cue being more distinctive than the control cue (thus giving rise to a reaction time increase), a further study was conducted by Sayette and Hufford (1994). The protocol was identical to the first study but with a modification that allowed for a closer examination of the effect of deprivation and cue exposure on reaction time. To obviate the unplanned withdrawal effects observed in the non-deprived group in study one (which may have resulted in increased urge ratings) all smokers received the smoking cues before the control cues. In the non-deprived condition, smokers smoked a cigarette seven minutes before exposure to the smoking cue and reaction time task. With these modifications Sayette and Hufford (1994) expected to show that reaction time would be greater in deprived smokers. The results of this study corroborated the findings from the first study. The findings from both studies supported the conclusion that smoking cues influence cognition and self-reported urge to smoke in abstinent smokers. They also showed an association between information processing and urge to smoke.

Droungas, Ehrman, Childress, and O'Brien (1995) used a smoking-related video to investigate the notion that smoking cues induce non-smoking specific negative affect. A secondary hypothesis tested was that expectation to smoke affects smokers responsivity to smoking cues. Twenty-six smokers were allocated to either a 'smoke' or 'no smoke' groups. Each smoker smoked a pre-session cigarette. The 'smoke' group was told they could smoke in the waiting room, and the 'no smoke' group was told they had to smoke outside the building. In order to manipulate expectation to smoke the 'smoke' participants were told they would be able to smoke after the experimental sessions and the 'no smoke' groups were told they would have to leave the building before they could smoke. Three types of stimuli were used, smoking cues, neutral cues, and unpleasant cues. The smoking-related cues were video footage of a heterosexual couple smoking in various natural settings on the way to a job interview and a control video was of the life of hummingbirds. In addition, a smoking task which involved smokers holding a cigarette and lighter for five minutes and a neutral task required smokers to sort children's nursery rhyme cards. Thus, the video cues (smoking and neutral) were balanced with a smoking and neutral manipulation task. The unpleasant cues were a video showing saw mill accidents and a task involving sorting cards depicting a range of disturbing physical injuries and deformities. Every participant viewed the smoking video before the other stimuli, and to control for order effects each of the three laboratory sessions (smoking, neutral and unpleasant) were counterbalanced.

A paired adjective mood questionnaire was used to measure affect. Self-reports of desire to smoke, intention to smoke, withdrawal, and an item called 'high' (designed to measure whether smokers felt that they had just had a cigarette) was obtained pre session using a measure called the Drug Related States Scale (DRSS) developed by the authors (Droungas et al., 1995). The same measures were obtained pre cue presentation, during cue presentation and at the end of the session. In a post testing waiting room smokers in the 'smoke' groups were given their cigarettes and video recordings were used to measure latency to smoke. The 'no smoke' group were given the opportunity to eat sweets but not allowed to smoke.

Due to data collection errors only data from the 'smoke' groups only was obtained for the latency to smoke measure resulting in a small sample of eight participants. However, within the 'smoke' group shorter latencies were observed following the smoking cue session compared to the neutral cue session. The difference between the smoking cues session and the neutral session was not significant. Prior to formal analysis of the self-report data Droungas et al. (1995) decided to treat the video and task stimuli as a compound stimulus and collapsed the post video and post task DRSS data. A difference score was then calculated which involved subtracting the pre cue rating from the post cue rating for each session. Thus, the formal analysis evaluated changes in DRSS scores from a pre cue baseline of zero. Analysis of the baseline changes revealed that there were no significant effects of cue exposure on the DRSS scores at either pre- exposure, post-exposure, or end of session stages for the 'no smoke' group. For the 'smoke' group, desire to smoke reports were significantly higher following exposure to the smoking cue. The withdrawal reports were also sensitive to the smoking cue compared to neutral cues at the post cue interval but was not significantly different from the effects of the unpleasant cue exposure on 'withdrawal'. For the 'high' component of the DRSS there was a distinctly different pattern of results. In the SMOKE group only the unpleasant cue change scores were significantly different from zero, neutral and smoking cue effects on 'high' were negligible.

Analyses showed that in the 'smoke' group exposure to smoking cues moved mood from a baseline moderate positive level to a more neutral mood state. The unpleasant cues in the same group moved mood from the positive to a significantly negative level. Overall, the findings supported the hypothesis that smokers experience increased craving following exposure to smoking cues than to neutral or unpleasant cues. Unpleasant cues failed to affect desire to smoke or latency to smoke in both the 'smoke' and 'no smoke' groups. However, the expectation manipulation failed to influence craving, and there was no significant interaction between group and type of cue. In conclusion, this form of smoking cue (video and smoking task combined) seems to be effective in eliciting a craving state and influencing subsequent smoking behaviour in the form of latency to smoke. However, whereas this general conclusion may be sound, aspects of the cue stimuli used and the treatment of the cues in the analysis need to be considered. In their description of the cues used in their study Droungas et al. (1995) treated the videos and the tasks to be a 'single compound stimulus'. Clearly compounding a video cue with a task cue is problematic. We are not told whether the video had an audible sound track, and moreover, such a stimulus mixes context (eating, drinking, waiting for a bus, anticipation of a job interview) with the apparatus of smoking (lighter, matches, the cigarette, smoke, ash, etc). Whereas a smoking video depicts naturalistic smoking it is impossible to be exact about which aspect of the video, the context of the smoking, the affective tone of the film, the sound track or the concrete smoking-related stimuli in the footage were producing the observed changes in craving state or smoking behaviour. Task cues are therefore qualitatively different from video cues and in the design used by Droungas et al. (1995) it is not possible to divorce the effect of the video from the effect of the tasks as they were treated as a compound cue. Therefore, the validity and utility of video representations of smoking in themselves and when compounded with smoking-related tasks or other smoking-related cues needs to be assessed independently of task cue. Such confounds make a detailed and exact interpretation of reactions problematic (Niaura et al., 1992). Finally, a Stroop task was included among the tasks the participants had to perform during each experimental session at both pre cue and end of session stages. No data was reported from this task except a note that it will be reported elsewhere. It is possible that the stress inducing properties of the Stroop task induced a craving to smoke. Thus, the failure to control for the influence of this Stroop arousal may cloud the apparent certainty of the findings.

In summary, it is clear that the sight and smell of cigarettes have significant effects on topographical smoking behaviour, latency to smoke, self-reports of cravings and desire to smoke, and in several studies smoking-related cues have had a significant effect on mood or affect.

2.1.1 Smoking confederates

Another strong cue to smoke is the presence of another individual smoking. Several studies have adopted the use of 'confederate smokers' to represent the natural situation of being in the presence of a smoker. In most experiments a stooge smokes next to the participant in a manipulated but 'natural' smoking context (e.g. waiting in a corridor, outside a testing room). Abrams, Monti, Carey, Pinto, and Jacobus (1988) conducted a study of the reactivity of smoking cues and relapse using an opposite sex smoking confederate. Relapsed smokers, quitters, and controls (never-smokers) made up the between groups factor. The smokers initially abstained from smoking for 60 minutes prior to the presentation of a smoking cue exposure trial or (CUET). The CUET consisted of an audiotape instructing the participants to imagine a scenario in which they are waiting in a garage for a mechanic to complete work on their car. An unknown person then enters the waiting room and sits next to them. The confederate then prepares to and actually smokes in the presence of the participant. Participants were free to engage in conversation if they wished to do so. They were told the aim of the task was to resist the desire to smoke. Thus, there were three distinct phases; relaxation (to stabilise and habituate participants to the experimental environment), confederate preparation to smoke, and confederate smoking.

Each session was videotaped to record the behaviour of the participant and their interaction with the confederate. Heart rate was recorded and self-reported measures of anxiety and urge to smoke were obtained. It was found that heart rate increases were greater in the relapse group in the preparation and actual smoking phases, compared to controls. Self-report measures revealed that relapsers had significantly higher urges to smoke and anxiety scores compared to quitters and controls. A prospective study reported in the same article suggested that cue reactivity using CUET was related to relapse in a group of smokers who received smoking cessation treatment and were followed-up after six months. The follow-up group heart rate reactions discriminated between those who did quit and those who did not. The conclusion from this finding is that the magnitude of reactions to cue exposure pre treatment is predictive of success or failure in attempts to quit smoking. The implications for smoking assessment and cessation interventions are immediately obvious. Abrams et al. (1988) argue that multiple measures, in particular heart rate and cognitive indices would be useful assessment tools in evaluating treatment efficacy and the appropriateness of certain treatments for different smokers.

Niaura, Abrams, Demuth, Pinto and Monti (1989) used the same CUET procedure as Abrams et al. (1988) in a study of smoker's reactions to smoking cues and interpersonal interaction. Smokers were given a CUET exposure trial and multiple measures were obtained (including heart rate, skin conductance, and self-report measures of urge to smoke and anxiety prior to them receiving smoking cessation treatment). Three months post treatment smoking status was assessed and ten smokers from the original cohort reported continuous abstinence post treatment, ('quitters' group). Another ten smokers were chosen at random from those who had failed to stop smoking post ('relapsers' group). Pre-treatment measures were evaluated to determine predictive relapse. The measures of skin conductance, urge and anxiety did not predict successful abstinence However, the relapsers inter beat intervals (IBI's) (obtained by measuring distance between successive R-waves of the PQRST waveform) increased in the relapsers and quitters showed a small deceleration in IBI. However, a close inspection of Niaura et al's. (1989) statistical procedure questions the validity of their findings. Of particular concern were the limited IBI session, posy hoc sampling procedures and violation of parametric testing assumptions and small sample size.

One issue that brings into question the use of a smoking confederate as a smoking cue is the confound created by mixing smoking stimuli (such as a lit cigarette, cigarette smoke, a lighter) with the person smoking the cigarette. What is not possible using this technique is to be sure which component is contributing most to the reactions observed in the participant, the cigarette, the person holding the cigarette, or their interaction. Therefore, the observed changes in smoking urge, topographical smoking behaviour and physiological measures may be related to social anxiety. Self-report data, about the participants reactions to the confederate was not taken in these studies. In an attempt to address this methodological issue a study by Niaura, Abrams, Pedraza, Monti, and Rohsenow, (1992) provided evidence of a cue-confederate interaction effect. In this study a confederate was present or absent in the three smoking cue levels. In the first level visual cues were present, in the second visual and olfactory cues, and in the third no cues were present. Results showed an interaction between smoking cues and confederate presence. It was found that when the confederate held and manipulated an unlit cigarette, and the participant engaged in role-play, urge to smoke showed the greatest increase, but decreased when the participants saw the confederate smoke the cigarette. Furthermore, analyses showed that urge response and physiological response were independent. Whilst physical smoking cues significantly elevated cardiovascular responses urge increased only when the confederate presented the cues visually. This differential responding could be the operation of the non-automatic urge response mechanism suggested by Tiffany (1990). The physiological responses may be automatic and dissociated from non-automatic responses.

2.1.2 Visual imagery techniques

Training and instruction in visualisation techniques was developed by the Ancient Greeks in the form of mnemonic rehearsal strategies (Yates, 1966). The use of visual imagery techniques in smoking research has been effectively developed by Tiffany in a thorough and influential investigation of smoking urges (Tiffany & Hakenewerth, 1991; Tiffany, 1990; Maude-Griffin & Tiffany, 1996). The technique involves participants either reading or listening to passages that include scenarios of smoking episodes. Sometimes the affective tone is also manipulated in order to determine the influence of affect on smoking cue and responses to their combination. These imagery manipulation techniques successfully produce craving states and urges to smoke. They have also been used to delineate the relationship between smoking urge and affect (Tiffany, 1990; Tiffany, and Hakenewerth, 1991). For example, Tiffany and Hakenewerth (1991) studied smokers physiological and self-reported urges to smoke following an imagery induction task. Urge scripts were used which contained explicit descriptions of a scenario involving an escalating urge to smoke in a familiar context, (drinking with friends, feeling relaxed in the company of other people smoking). The neutral scripts replaced references to smoking with a washing up scenario. The results indicated that participants reported significantly stronger urges to smoke in response to the urge scripts than to the neutral scripts. The physiological data also revealed a differential response to the scripts. It was found that heart rate significantly increased from baseline during urge scripts compared to neutral scripts. Overall, the findings supported the notion that imagery manipulations are potent cues to smoke. Moreover, it was found that none of the physiological measures that were used by Tiffany and Hakenewerth (1991) were significantly correlated with their self-report measures. This finding is supported by evidence from studies of other recreational drugs and is used by Tiffany to refute commonly held beliefs about the generation of urges and the role of physiological systems that are related to them.

2.1.3 Smoking-related words

Experimental investigations employing smoking-related word lists have recently been developed in smoking behaviour research. Typically this approach investigates the processing of matched neutral and smoking word sets (Litz, Payne & Colletti, 1987; Gross, Jarvik & Rosenblatt, 1993). Examples of the smoking-related words used include; smoke, tobacco, ash, lighter, matches, cough, smell, and ashtray. The development of a set of smoking-related words involves smokers and non-smokers providing as many words as they can think of which are related to smoking. A separate panel of smokers then rate the first set of words on a relatedness to smoking scale and the highest rated words are selected for experimental investigation into cognitive biases in smokers.

One reason why smoking-related words have received little attention in the smoking behaviour field may be because words or phrases are abstracted forms of smoking-related stimuli. However, concrete stimuli, as we have seen from the previous review are problematic. Frequently the stimulus configurations inherent in presenting smoking-related cues or stimuli involve complex interactions between context, sensory factors, and many other environmental factors. The consequence is that observed effects may be influenced by overt characteristics of the stimulus as well as more subtle and hidden characteristics or aspects of the stimulus configuration. Therefore, the use of smoking-related words is advantageous in that it allows for the analysis of uncounfounding definable stimuli. Furthermore, the use of smoking-related words allows the researcher to utilise a range of response measures employed in other fields.

The first study to use smoking-related words was conducted by Litz, Payne and Colletti (1987). They hypothesised that schemas provide a structural mechanism in which past experiences are used to select, structure, and organise incoming information. A mixed experimental design was employed in which group (smoker/never smoker) by reference (self reference/non-self reference) by word (smoking /driving /skydiving) factors were investigated by valence (positive or negative). The main dependent measure was a schema reaction time task. In a typical trial a sentence stem appeared on a monitor followed by a word which remained on the screen until a YES or NO response was made. Self-referent stems were constructed so that participants always evaluated the word against a sentence stem that started with the word "My" (e.g. " My driving is fast....".) Non referent stems did not enhance self-reference processing of words, (e.g. "Driving is fun.....", "Smoking is bad...".) This complex design allowed for an investigation of the processing of both negative and positively valenced smoking-related words in smokers and non-smokers. The reference factor was included to investigate the influence of making self-referent judgements on the schema reaction time task. It was found that the reference factor had no significant effect on any dependent measure. Furthermore, there were no significant differences between smokers and never-smokers on any control stimuli measures. However, it was found that never-smokers had shorter latencies to negative smoking words than to positive smoking words, and smokers had shorter latencies to positively valenced smoking words than never-smokers. The results of this study suggest that smokers have smoking-related schemas (SRS) which give structure to the smokers past experiences and memories for smoking. The implication is that a schema contains smoking-related information that is easier to recall. The ongoing behaviour of smoking then presumably leads to a rich and diverse smoking-related schema, which is unique to smokers. It could be concluded that smokers smoking-related schema are biased toward a positive smoking-related content, and if never-smokers posses a SRS then it is of a more negative nature. It was also found that biases possessed by these two groups are expressed in memorial performance. Litz et al. (1987) showed that smokers recalled significantly more smoking words then never-smokers.

Gross, Jarvik and Rosenblatt (1993) conducted a modified Stroop task study of smokers and non-smokers processing of smoking-related words. Smoking-related words matched with neutral words were presented to smokers and non-smokers on cards. The participants task was to name out loud the colour of the ink they saw whilst trying to ignore the word itself. Prior to a testing session smokers were randomly allocated to an abstinent (12 hours overnight) or normal smoking group. Following this manipulation each group were administered the modified Stroop task and the total time taken to colour name each set of words was recorded. The results showed that abstinent smokers took more time to colour-name smoking words than neutral words. The conclusion from these findings is that abstinence from smoking activates cognitive processing which is biased towards smoking-related information, that is, abstinence makes smokers preoccupied with smoking-related stimuli.

Jarvik, Gross Rosenblatt and Stein (1995) provide additional evidence of the effects of abstinence on processing of smoking-related stimuli. In the first experiment reported, heavy smokers were allocated to an abstinent or non abstinent condition, and following overnight abstinence or normal smoking, participants completed a perceptual identification task in which words (smoking/food/neutral) were briefly presented on a computer screen followed by a mask. Participants were told to identify the word as quickly as possible to the experimenter. The dependent measure was the number of words correctly identified. It was hypothesised that abstinent smokers would be able to correctly identify more smoking words than the non-abstinent smokers. The results supported these predictions. Abstinent smokers correctly identified an average of eight and a half smoking words which was significantly different from their scores for the other word categories. Moreover, only the abstinent smokers demonstrated this pattern of performance. In the second experiment a further group of smokers were entered into a two by two mixed factorial design. Abstinent smokers and active smokers were required to categorise smoking and food-related words as quickly as possible by pressing designated response keys. Abstinent smokers made faster category decisions for smoking words compared to food words. Non-abstinent smokers made slower category decisions for smoking words compared to neutral words. The combined findings from the perceptual identification task and the category task suggest that abstinence facilitates the processing of smoking-related material, and that smoking-related concepts and semantic representations of smoking-related material are primed during abstinence. The Gross et al. (1993), and Jarvik et al. (1995) findings both support this hypothesis, and are in line with findings from Litz et al. (1987) which suggested that smokers and non-smokers have specific semantic structures in memory which when activated guide and determine the processing of smoking-related stimuli.

The findings from the studies reviewed in this section point to several important issues that are pertinent to this thesis. The indication is that smokers compared to non-smokers, and abstinent smokers compared to non-abstinent smokers process smoking-related words in different ways, (Litz, 1987; Gross, 1993; Jarvik, 1995). Furthermore, they suggest that abstinence is accompanied by cognitive bias for smoking stimuli such that such stimuli are difficult to ignore during abstinence and capture cognitive resources. However, there are a limited number of studies available to support this hypothesis. Moreover, there is inconsistency in the type of dependent measures used to index biases. Therefore, it is the aim of this thesis to bring evidence to bear on the central issue of cognitive bias in smoking abstinence and to explore the role of individual differences in smokers' processing of smoking-related stimuli through the systematic use of reliable and appropriate measures.

2.2 Summary

A number of studies investigating the role of smoking-related cues on smoking behaviour, urge to smoke, affective state and physiological reactions have been evaluated. These have shown that a variety of cues can influence smoking behaviour in very different ways. They have also influenced cognitive and physiological processes which individuals may not be aware of. Clearly, there is much scope for the further use of these variables.

In conclusion, it is argued that gathering more evidence concerning the processing of smoking-related words by smokers, abstainers and non-smokers is important for the progression of smoking research and a deeper understanding of the role of cognitive factors in smoking behaviour. Furthermore, the effect of abstinence on smokers processing of smoking-related cues requires further investigation, together with individual differences that may be related to abstinence response. The development and use of finer grained stimuli in the analysis of smokers' reactions to smoking-related stimuli combined with the use of cognitive based objective measures could provide further information about smoking behaviour. Moreover, the use of reliable self-report measures of affect and smoking motivation, and measures of cognitive processing would be important ingredients in any experiment hoping to provide robust evidence. Before attempting to provide such evidence a description and evaluation of the range of subjective and objective measures used in smoking-related cue research is required.

Chapter Three

A Review of the Methods and Measures Used in Smoking Research

3. Introduction

The previous chapter evaluated studies that used various forms of smoking-related stimuli in investigations of smoking behaviour and cue reactions. It concluded that the characteristics of the smoking-related independent variable used in any experimental design has to be carefully considered because it is equally important to consider the measures used to determine such factors as smoking status, smoking motivation cravings, and smokers reactions to abstinence and smoking-related stimuli. The aim of this Chapter is to describe and evaluate the range of self-report measures and dependent measures that have been used in investigations of smoking-related cue responses. The methods and measures reviewed in this Chapter include cigarette consumption, carbon monoxide measurement, dependency, craving, smoking motivation, anxiety, and finally reaction time based measures of attention (Stroop and Dot Probe). Combined with theories and protocols previously discussed these should provide a firm basis from which to carry out a series of investigations into smoking behaviour.

3.1. Carbon monoxide measurements

Expired air Carbon Monoxide (CO) measurement is a reliable and non-invasive measure that is used to determine recency of smoking and to corroborate smoking status, where self-reported smoking status has been shown to be unreliable (Sillett, 1978). One of the by-products of tobacco combustion is CO. This is inhaled with the tobacco smoke when the smoker drags on the cigarette. CO quickly enters the blood stream through the alveolar interface and binds with the haemoglobin molecule to form Carboxyhaemoglobin. Because CO has a half-life of approximately three-five hours it is a valid corroborative measure of recent smoking (Jarvis, 1980; Lando, 1991; Kozlowski, 1988, Gross, 1993). Expired air CO measures have recently become available and are increasingly being used in clinical and experimental contexts where researchers cannot afford very expensive alternatives or require instant feedback to be given to smokers. Irving, Clark, Crombie and Smith (1988) have evaluated a portable measure of expired-air carbon monoxide. This was an efficacy study of a cheap and portable expired air CO measurement instrument called a Bedfont EC50 'Smokerlyzer' (Bedfont Technical Instruments Ltd., Sittingbourne, Kent). It was found that the Bedfont instrument was as effective in identifying smokers and non-smokers as the considerably more expensive 'Ecolyzer' instrument which requires weekly calibration.

There is some evidence that CO measures can be insensitive to low levels of smoking, and may be unable to distinguish between passive, light and moderate smoking (Lando, 1991). However, the measure has been successfully used to corroborate overnight abstinence (West, 1985; Payne, 1991; Gross, 1993; Jarvik, 1995; Rosenblatt, 1996) and as a check of smoking status (Tiffany, 1991; Kassel, 1997). Gross, Jarvik and Rosenblatt, (1993) used a portable CO measuring device to confirm the strength of an abstinence manipulation in an investigation of smokers processing of smoking-related words. It was found that smokers who were abstinent for 12 hours had significantly lower CO readings compared to active smokers. Finally, Campbell, Sanson-Fisher and Walsh (2001) conducted an assessment of self-reported smoking status against CO in 7,405 pregnant women and found that CO had high sensitivity (87%) and specificity (93%) against self-reported smoking status. Although they do acknowledge that there are some difficulties in determining the contributions of passive smoking and inaccurate report when CO measures and self-report are inconsistent.

For the purposes of the present thesis CO measures will be used for the corroboration of abstinence. As has been argued expired air CO measures are an effective measure of recent smoking, and this method is suitable for verifying self-reported abstinence. Based on the available evidence it is expected that six hours of abstinence will result in an average reduction in CO levels of 50% (Kozlowski, 1988). Although individual CO levels pre-abstinence may vary, Lando et al. (1991) provide mean CO levels for light (14.3ppm, 1-15 cigarettes per day) moderate (24.7ppm, 16-24 cigarettes per day) and heavy (33.3 ppm, 25 cigarettes per day or more) smokers. These values provide working levels for comparison. Irvin et al. (1988) also provide useful CO criterion data for non-smokers (2.7ppm) and smokers (24.5ppm) as well as the finding that there is a clear dose-response relationship between reported expired air CO levels and cigarette consumption. Furthermore, Gross, Jarvik and Rosenblatt (1993) provide useful comparative data for changes in CO levels in abstinent and active smokers. In this study overnight abstinence resulted in significant differences in CO levels between abstinent and active smokers. The abstinent smokers mean CO was 8.9ppm (range 4-14), and the active smokers mean CO was 22.3ppm (range 11-48). The range overlap in this data is probably due to different starting levels of pre-abstinence smoking recency contributing to a wide range of pre-abstinence CO levels. Differences in the number of cigarettes smoked prior to participation a study could also contribute to different levels of expired CO following abstinence. The present thesis will ensure that all smokers have smoked one hour prior to participation in experiments. Thereby ensuring that all smokers present with approximately equivalent CO levels pre abstinence. Furthermore, self-report will be used to determine adherence to abstinence protocols in future studies. It will be expected that CO readings in abstinent smokers will be reduced from pre-abstinence and be significantly lower than active smokers CO levels.

In summary, expired CO measures using relatively cheap and portable equipment are an invaluable and reliable measure of smoking status and recency of smoking. They are also well suited to corroborate self-reports of smoking status in studies of abstinence.

3.1.2 Measures of dependency

Despite the long debate about the use and abuse of the term dependency in smoking, it would be imprudent to ignore the notion that smokers are dependent on nicotine. However the criteria for dependence on nicotine included in the various revisions of the Diagnostic and Statistical Manual of Mental Disorders is of little use in determining whether smokers are dependent because it is not specific enough. An alternative dependence instrument called the Fagerström Tolerance Questionnaire (FTQ) was developed and tested by Fagerström (Fagerström, 1978; 1989). This measure is useful for measuring the degree of physical dependence in smokers and is a good predictor of craving and withdrawal (Gunn, 1983; Killen et al., 1992; Hughes & Hatsukami, 1986). The measure has a three factor structure: Smoking dosage, morning smoking (as measured by the latency to the first cigarette after waking) and ability to refrain from smoking. Of these three, morning smoking seems to be the factor most predictive of cessation outcome and withdrawal symptoms. Payne, Schare, Levis and Colletti (1991) used the FTQ to explore its relationship with affect and desire ratings in a study of smoking-related cue exposure on topographical smoking. They found that FTQ scores were significantly correlated to topographic measures but not 'desire to smoke' ratings. Nevertheless, the FTQ is a useful instrument in the context of this thesis because it is a reliable method of identifying individual dependence in smokers, (Fagerström, 1989).

3.2 Measures of craving

As Tiffany (1990) has noted, the concept of craving is central to many theories of smoking behaviour. Because previous studies lacked validity and reliability Tiffany and Drobes (1991) developed the Questionnaire of Smoking Urges (QSU). The QSU represents four distinct conceptualisations of drug urges: desire to smoke; anticipation of positive outcome; anticipation of relief from withdrawal or negative affect and intention to smoke. Following testing on a large sample of smokers analysis revealed a stable two-factor solution. Factor one was characterised by items related to a desire to smoke, anticipation of positive effects, and smoking pleasure. Factor two represented items related to alleviation of negative affect and increased clarity of thought. Consequently, Tiffany suggested that because urges have at least two dimensions single or double item measures of craving fail to capture the complex nature of urge responding.

Despite Tiffany's observations, the majority of investigators continue to use face valid items to measure craving. Likert scales of varying dimensions have been used to obtain interval type data. Usually a numbered scale is used; such as a 1= "not at all" to 7= "very much" (Payne, 1991), a 1= "no urge to smoke at all" to 10= "very strong urge to smoke" (Sayette, 1994; Droungas, 1995), or a 100 point visual analogue scale (Hatsukami, 1991; Tiffany & Hakenewerth, 1991; Tiffany 1996).

3.3 Smoking Motivation

Several questionnaire based measures have been developed to determine a typography of reasons for smoking. Ikard, Green and Horn (1969) developed one of the first scales. They recognised that in the late sixties smoking research tended to regard smokers as a homogeneous group, only occasionally differentiating smokers according to the number of cigarettes they smoked. Following a conference report by Tomkins (1966; cited in Ikard, 1969) which presented a theoretical rationale for differentiating smokers according to types of affect regulation, Ikard et al. (1969) sought to develop a measure of smoking motivation related to the management of affect. They based their analysis on a previous 23-item questionnaire developed by Horn and Waingrow (1965, cited in Ikard, 1969). Data from the Horn and Waingrow items using a sample of smokers (n=2094) from a college and a New York clinic were factor analysed. The results supported the smoking typology formulated by Tomkins (Tomkins, 1966; cited in Ikard, 1969; Tomkins, 1968). Six factors were derived from 18 of the original Horn and Waingrow 23-item scale. These were: habituation; addiction; negative affect reduction; pleasurable relaxation; stimulation and senorimotor manipulation. Thus, Ikard et al. (1969) successfully developed a smoking motivation scale, (the Reasons for Smoking Scale, RSS) grounded in the smoking theory of that time.

A later examination by Russell, Peto and Patel (1974) failed to find the negative affect reduction factor. Subsequently a new measure was developed called the Smoking Motivation Questionnaire (Russell et al., 1974; West and Russell, 1985). This new 27-item scale comprised seven sub-scales: Smoking for image, hand-mouth motivation or psychomotor smoking, indulgent smoking, smoking for stimulation, smoking for sedation, smoking to relieve craving or dependent smoking, and automatic smoking. West and Russell (1985) found that the dependent sub-scale of the SMQ was correlated with craving and irritability and withdrawal severity following 24 hours of smoking abstinence.

More recently the SMQ has been used to investigate the role of individual differences in the relationship between stress and smoking behaviour (O'Neill, 1992; Parrott, 1993; Parrott, 1994; Parrott, 1994; Parrott, 1994a; Parrott, 1994b; see review in Parrott, 1995). The results showed that the sedative sub-scale was significantly related to degree of self-reported stress change. Parrott (1995) also found that the sedative, stimulant, automatic and addictive sub-scales clustered together to constitute a higher order factor referred to as a pharmacological addiction factor. This analysis and other investigations of the SMQ show that the SMQ is a useful tool in the investigation of individual differences in smoking behaviour. However, there is little research concerning the factor structure and reliability of the SMQ. Moreover, no research studies have investigated smoking motivation in relation to abstinence and the processing of smoking-related stimuli. As this measure may provide useful data about the effects of abstinence and cue exposure it is necessary to conduct factorial and reliability analyses.

3.4 Measures of affect

Researchers have adopted a varied range of measures of emotion, mood, or affect. Likert rating scales were used by Payne, Schare, Levis and Colletti (1991) in a study of the effects of smoking-relevant cues on smoking behaviour and self-reported affect. Several affective dimensions represented: by; sad/depressed; angry/frustrated; good/happy; annoyed/stressed; calm/relaxed and tense/anxious were observed. When the scales were used to represent the bi-polar dimensions, (negative/positive), a sensitivity to a negative affect induction procedure was observed. Furthermore, negative affect ratings were significantly related to self-reported desire to smoke. Droungas, Ehrman, Childress and O'Brien (1995) used an 11-point adjective pairs 'mood questionnaire' (irritable-social, unpleasant-pleasant, anxious-calm, and sad-happy). Results showed that the four adjective pairs were subsumed into a two dimensional measure of positive and negative affect. In experimental analyses they found that unpleasant videos produced a significant change in negative affect ratings, and neutral videos produced a significant increase in positive affect. Similar linear mood questionnaires have been used in studies of smoking urges (Tiffany, 1990, 1996). However, such measures may be considered to be inaccurate ways of measuring the complex nature of affective states and capturing the subjective experience of anxiety. As Glautier and Tiffany have noted 'home-made multi-item mood questionnaires are used typically with no evaluation of their psychometric properties, and it is possible that their reliability is considerably less than assumed' (Glautier & Tiffany, 1995, p.85). What is required therefore is the application of a more reliable and more widely validated measure of anxiety, one that measures the state and trait anxiety factors that may have a significant influence on smoking behaviour and reactions in smokers to abstinence.

Perhaps the most common and widely used measure of state and trait anxiety is the Spielberger State and Trait Anxiety Inventory (STAI) (Spielberger, 1983). This measure has been used in various contexts, including assessments of General Anxiety Disorder. (Mathews, 1985; Eysenck, 1993; Eysenck, 1991; Eysenck, 1992b; Broadbent, 1988), and attentional bias in other emotional disorders (MacLeod, 1986; MacLeod, 1988). The STAI has also been used in investigations of smoking's effects on pain, anxiety and stress (Pomerleau, Turk and Fertig, 1984; Fleming, 1987; Kassel, 1997; Dobbs, 1981; Levin, 1991). The trait sub-scale has been applied to comparative studies of the personality characteristics of smokers and non-smokers. For example, Spielberger and Jacobs (1982) found significant differences between male and female smokers and non-smokers. They found that whilst female smokers had higher trait anxiety scores than female non-smokers, male smokers had lower trait anxiety scores than male non-smokers. Patton, Barnes and Murray (1993) found that smokers and smokers who had quit had significantly higher trait anxiety scores than never-smokers. Spielberger (1986) found that trait anxiety correlated with self-reported motivations to smoke during states of high anxiety. In summary, whilst the trait sub-scale of the STAI has been implicated in smoking there has been little reporting of the predictive utility of the state anxiety sub-scale. As a reliable and sensitive instrument the STAI may be used to index the effects of smoking abstinence on anxiety. The sensitivity of the STAI to periods of smoking abstinence will be investigated in subsequent experimental chapters along with its relationship with smoking motivation.

3.5 Cognitive and physiological measures of smoking cue response

The review of self-report measures of psychological states showed that they provide valuable information about smoking behaviour. However, their usefulness is dependent upon an association with objective measures (Valentine, 1992). This is because cognitive and physiological measures provide data that is less contaminated by social desirability, cognitive penetration, tacit knowledge and task demands. Researchers investigating smoking behaviour have frequently used physiological measures. The specific measures used are: blood pressure (Niaura, 1992; Hepple, 1996) heart rate, (Abrams, 1988; Niaura, 1989; Hatsukami, 1991) skin conductance (Tiffany, 1991, 1996) and finger temperature (Tiffany, 1991, 1996). Generally these measures have been used (in combination with subjective measures) to investigate reactions to smoking cues following withdrawal (Hatsukami, 1991). One significant feature of these non-invasive measures is that they are easily obtained with little inconvenience to the participant. However, ease of measurement is not mirrored by ease of interpretation. The problem is that different physiological systems interact, and it is not clear whether the same systems serve the same smoking-related response. Glautier and Tiffany (1995, p.89) argue that '..even within any one domain, there is little evidence of a unidimensional process controlling all responding'. Therefore, to assume that a single measure fully describes a particular response is wrong because there is not an identity between a psychological process and a physiological reaction. Physiological systems such as the cardiorespiratory system may be related to many cognitive or psychological processes (Tiffany, 1990).

Reaction time measures are another domain of objective measures have been used to investigate the impact of nicotine on human information processing. The general hypothesis tested is that because nicotine has beneficial effects on some forms of information processing and cognitive functioning. A rapid visual information-processing task developed by Wesnes and Warburton (1978) has been used by some researchers (Parrott, 1989). The task requires high levels of concentration and the evidence suggests that smoking and nicotine delivery improve performance on the task. Warburton and Walters (1989) have reviewed the evidence for smoking effects on attentional processing and concluded that smoking improves attention and that smokers realise this benefit. However, Wesnes and Parrott (1992) argue that it might be that smokers are compromised by the absence of nicotine and not benefited by its presence. That is, performance on information processing tasks following abstinence may not reflect performance enhancement but show a reinstatement of pre-deprivation performance levels. However, more recent studies have addressed some of the concerns expressed by Wesnes and Parrott (1992) over nicotine delivery and experimental methods, and have found results consistent with Waburton and Walters findings (Le Houezec, 1994; Bates, 1995).

3.6 Measures of cognitive bias

Recent research and theory development has focused upon cognitive biases in smokers (Gross, Jarvik & Rosenblatt, 1993; Jarvik, Gross, Rosenblatt & Stein, 1995; Rosenblatt, Jarvik, Olmstead & Iwamoto-Schaap, 1996; Johnsen, Thayer, Laberg & Asbjornsen, 1997). More specifically, they suggest a cognitive bias that facilitates and prioritises the processing of smoking-related information following abstinence. These findings are of direct relevance to the present thesis. Williams, Watts, MacLeod and Mathews (1988, p.54) have provided a working definition of attentional bias;

> 'We assume attentional bias can be said to have occurred when there is a discrete change in the direction in which a person's attention is focused so that he/she becomes aware of a particular part or aspect of his/her stimulus environment'

Cognitive biases have been found in many psychopathological conditions including: anxiety (Mathews, 1985; MacLeod, 1986; MacLeod and Mathews, 1991; Mogg, 1989; Mogg, 1994) depression (Mogg, 1995; Bradley, 1988; Gotlib, 1988; MacLeod, 1987) specific fears and emotional conditions such phobias (Mattia, 1993; Barker, 1997) post traumatic stress disorder (Ehlers, 1988; McNally, Kaspi, Reiman & Zeitlin, 1990) and suicide (Williams, Watts, MacLeod & Mathews, 1990; Williams, Mathews & Macleod, 1986). These studies have demonstrated (through the use of a modified Stroop task) that processing in acute and chronic states of anxiety is characterised by selective and biased processing of items that are germane to the participants' disorder. For example, spider phobics demonstrate attentional bias for spider-related words (Watts, Trezise & Sharrock, 1986; Watts, McKenna, Sharrock & Trezise, 1986b).

Mathews and MacLeod (1985) used a modified version of the Stroop colour-naming task to investigate the selective processing of threat cues in anxiety states. Twenty-four patients with general anxiety disorder (GAD) and 24 non-anxious controls were presented with physical threat (e.g. injury, fatal) social threat words (e.g. foolish, stupid) and appropriate non-threat control words (e.g. contented, confident). Their task was to colour name the words presented without attending to the word content. Overall the GAD group took significantly longer to colour name both threat and non-threat words Moreover, the GAD participants took longer to colour name threat words compared to non-threat words. The non-anxious group had almost identical colour naming latencies for the two word groups. Furthermore, scores on the Spielberger state/trait anxiety sub-scales revealed that state anxiety was significantly related to the Stroop interference effect. Trait anxiety and depression scores were not. This suggested that the attentional bias observed in the anxious group was due to state effects and not trait effects in the participants. Because was the first study to demonstrate attentional bias in general anxiety it heralded the way for a wave of research studies investigating attentional biases in emotional disorders.

As was noted in Chapter One the information-processing paradigm provides a strong theoretical framework for the investigation of smoking abstinence. According to Tiffany's cognitive processing model (Tiffany, 1990) forced abstinence interrupts the normal execution of drug use action plans and elicits non-automatic processes and drug urges. In a state of craving an cognitive bias may arise that makes the smoker more sensitive to smoking cues in the environment. Furthermore, certain smokers in particular negative affect smokers and addictive smokers, (as defined by a smoking motivation measures such as the Smoking Motivation Questionnaire, West & Russell, 1985) may be prone to developing cognitive biases towards the processing of smoking-related stimuli. The process may have a cumulative effect, and an increase in anxiety may strengthen the conditioned response to smoking cues leading to relapse.

3.6.1 The use of the Stroop test in smoking research

One measure frequently used to assess cognitive bias is the Stroop test. In 1935 Stroop found that the speed of naming the colour in which words were printed was much slower when the words colour names were incongruent with their ink colour (Stroop, 1935). Since this original finding the protocols have been used in different contexts to examine the impact of certain classes of words on the Stroop effect.

Suter and Battig (1973) conducted one of the earliest studies of smoking behaviour using the Stroop task as an arousal-inducing device to investigate the "Nesbitt-paradox" whereby smoking is thought to produce subjective tranquillisation and sympathetic arousal (Nesbitt, 1973). However, no significant findings were observed. Wesnes and Warburton (1978) were more successful when they administered nicotine tablets to smokers and non-smokers and used the Stroop colour-naming task to investigate the effects of nicotine on information processing. It was found that after two testing runs there was a significant reduction in the size of the Stroop effect following the administration of nicotine. There were no differences on Stroop performance between smokers and non-smokers which suggests that smokers and non-smokers do not respond to nicotine differentially. In contrast, a later study by Wesnes and Revell (1984) found no drug effect on the same Stroop task. Provost and Woodward (1991) examined the effects of nicotine gum on the repeated administration of the Stroop task and found that nicotine administration did not affect colour reading and colour naming times but the time taken to colour name incongruous colour word stimuli did decline across trials. This finding suggests that nicotine effects information processing, not by altering attentional mechanisms but by altering the allocation of resources to non-automatic processing. Wesnes and Parrott (1992) reviewed the few studies that have used the Stroop task in investigations of nicotine's effect on distractibility and width of attention. They concluded that the evidence for nicotine's effects on the Stroop task was inconclusive and that the available data was not 'problem free'. However, they also concluded that evidence from other measures of information processing suggest that smokers perform these tasks more efficiently when smoking.

The first study that looked specifically at the cognitive processing of smoking-related information in smokers using a modified Stroop test was conducted by Gross, Jarvik and Rosenblatt (1993). Gross et al. (1993) randomly allocated a group of 22 smokers (who were receiving treatment for drug and alcohol addiction), to 12-hour abstinent group and an active smoking group. Using a modified version of the Stroop colour naming task it was found that abstinent smokers demonstrated a Stroop interference for smoking-related words (e.g. lighter). The effect was not present in the normal smoking group. Although it could be argued that the poly-drug sample used by Gross et al. (1993) is not representative of 'normal' smokers. Gross et al. (1993) claim that this result supports the hypothesis that abstinence produces a content specific shift in cognitive processing. Furthermore, they also state that this retardation in colour naming performance cannot be attributed to the decrease in cognitive functioning brought about by the reduction in plasma nicotine levels in the abstinent smokers.

Johnsen, Thayer, Laberg and Asbjornsen (1997) used a modified version of the Stroop task in active smokers, abstinent smokers, and non-smokers to determine whether abstainers show a cognitive bias favouring the processing of smoking-related words. Thirty-one participants took part in the study comprising; 11 abstinent smokers (recruited from an unspecified smoking cessation program who had been abstinent for three days) 11 active smokers and 11 non-smokers. Stroop colour words, smoking words and matched neutral words (both unspecified) were presented to the three groups and verbal reaction time (VRT) was recorded for each word trial. All three groups were slower at colour naming for the Stroop word trials compared to the neutral word trials. Moreover, a between groups analysis showed that the active smokers had significantly slower colour naming than the abstinent smokers. The same pattern of responses was found for the neutral word trials. This finding stands in contrast to the findings of the Gross et al. (1993) study where abstinent smokers were found to have slower colour naming reactions to smoking words compared to active smokers. Johnsen et al. (1997) suggest that this result reflects the failure of the active smokers to modulate attentional processes caused by decreased vagal control following smoking, as no physiological measures were obtained this hypothesis is speculative. In considering the apparent absence of information processing bias in the abstinent smokers responses, Thayer et al. (1997) suggest that it may be due to smoking cessation treatment effects. A similar effect was found in a spider phobia study carried out by Watts (1986) which found evidence of reduced cognitive bias in spider phobics following treatment. However, no details of the smoking cessation study that the abstinent groups were receiving were reported, so it is difficult to evaluate the claim that treatment may have ameliorated the abstinent groups responses to the smoking–related words.

With these caveats in mind the Gross et al. (1993) and Johnsen et al. (1997) studies suggest an anomaly that requires a more detailed investigation into the intervening variables associated with information processing bias to smoking-related stimuli. The paucity of studies that have used the Stroop protocol to study smoking behaviour suggests that more investigations need to be conducted to clarify the nature of information processing bias following smoking abstinence. This issue is explored in Chapters Five Six and Seven.

3.6.2 The Dot Probe task

Whilst many researchers claim that modified Stroop task effects are attributable to attentional bias the observed effect may be due to non-attentional processes. This has led some researchers to develop alternative measures. For example, MacLeod, Mathews and Tata, (1986) eveloped a paradigm which attempted provide more direct data concerning selective attention and biased visual attention in anxiety. The key was to acquire responses to stimuli that are not affectively toned but which still measure bias to affectively toned words. In the original study participants were presented with simultaneous presentations of threat or neutral words on a VDU screen. The words appeared briefly and they were asked to call the top word out loud. On some of the trials a small dot was randomly programmed to appear where the word had been, when this happened participants were told to push a response button as quickly as possible. On half of the trials the dot replaced the top word, and on the other half it replaced the bottom word. Findings indicated that anxious patients and control subjects demonstrated differential responses depending on the location of the dot and whether it followed a threat word or a neutral word. If the dot followed a threat word anxious patients responded quicker than if a neutral word was presented. If a dot replaced a neutral word at the bottom with a threat word at the top anxious patients responded slower. The implication is that the anxious participants were orienting or speeding towards the location of threat and whilst the controls were orienting away from threat. MacLeod et al. (1986) argue that the Dot Probe measures the allocation of resources in response to a neutral non-affectively toned probe occurring in the vicinity of self referent or threat material. This protocol has obvious advantages over the Stroop paradigm as it is independent of response bias problems. It therefore provides evidence of the existence of a decision mechanism that is sensitive to levels of threat or emotion-related material, and allocates attention to different aspects of the environment. The Dot Probe has received little attention in the smoking literature but has been widely used to investigate general anxiety (MacLeod, 1988; Broadbent, 1988; MacLeod, 1992).

As yet there are no published studies that have used the Dot Probe in smoking research. It would be advantageous therefore to adopt both the Stroop and Dot Probe measures in an analysis of the effects of abstinence on the processing of smoking-related cues in smoking in order to investigate their utility as measures of cognitive bias in smokers. This approach will seek to validate the use of Dot Probe in the context of smoking and extend the present understanding of cognitive bias in smokers. The Dot Probe task is utilised in Chapter Eight where it used to investigate attentional processing in abstinent smokers.

3.7 Summary

In this chapter a review of the methods a measures in smoking research was undertaken. These included a comprehensive range of self-report measures, the Spielberger STAI and the Smoking Motivation Questionnaire. Finally, the chapter considered measures of cognitive bias.

The information presented in these introductory chapters provides the theoretical and methodological framework for the development of a programme of research into smoking behaviour. The aims of the research are to systematically investigate the impact of smoking abstinence on the processing of smoking-related words and to assess individual differences in the processing of smoking-related words as measured by self-reports of anxiety and smoking urge. In order to gather data on cognitive bias in smokers it was decided to utilise two reaction time based measures. The modified Stroop task and the Visual Dot Probe task. These measures were chosen because the modified Stroop is a robust measure of cognitive bias, and the Dot Probe task is a direct measure of visual bias. Therefore, the adoption of these two protocols will allow for an effective evaluation of information processing bias in smokers from two perspectives.

Chapter Four

The Development and Validation of the Measures Used to Study Cognitive Bias in Smokers and Non-Smokers

4.1 Introduction

The previous chapters reviewed the literature on smoking behaviour from many perspectives. Specific to this thesis are a number of studies that have adopted a cognitive approach to the study of smoking by investigating smokers' processing of smoking-related cues. Principal among these is a study of abstinent smokers' processing of smoking-related words carried out by Gross et al. (1993). In this study smokers were presented with smoking-related words in a conventional Stroop colour-naming task. It was found that abstinent smokers took significantly longer to colour name smoking words compared to neutral words and that non-abstinent smokers did not show a content specific bias towards neutral words. This finding led Gross et al. (1993) to conclude that during abstinence smokers find it difficult to ignore smoking-related information. Subsequent studies have found similar results. For example, Jarvik, Gross, Rosenblatt and Stein (1995) studied a group of abstinent heavy smokers reactions to smoking words (the same words used by Gross et al. 1993) using a lexical decision task. The results showed that abstinent smokers identified significantly more smoking-related words than food-related or neutral words and were significantly better able to categorise smoking words than non-abstinent smokers. The conclusion drawn was that smoking-related concepts are primed and activated during abstinence from smoking. This links to a study by Rosenblatt, Jarvik, Olmstead and Iwamoto-Schaap (1996) which showed that abstinent smokers recognise significantly more smoking advertisements. Taken together, these findings support the general hypothesis that during periods of abstinence smokers experience a priming and activation of smoking-related concepts. Further, they show a cognitive bias for smoking-related stimuli which manifests itself in performances on cognitive tasks such as the Stroop colour naming task, lexical decision tasks and recognition memory tasks.

These studies provide useful information about the effects of smoking abstinence. However, there are significant issues that need to be considered. For example only one of the studies (Johnsen et al., 1997) employed a non-smoker comparison group. Thus, the majority of the studies were unable to confirm whether the cognitive bias observed was solely a function of smoking status. Indeed, such a result was found in the Johnsen et al. (1997) study where it was reported that non-smokers and abstinent smokers had longer colour naming latencies for smoking-related words compared to active smokers. Given that there is only one study of this type there is clearly scope for more investigations to be carried out. Moreover, none of the studies that have been reviewed so far obtained self-reported data additional to personal demograhics, smoking history, and ratings of cravings. Only the Johnsen et al. (1997) study gathered data on smokers attitudes towards smoking which was found to be negatively correlated with colour naming latency. It is therefore important to evaluate the role of smoking history and individual differences in smoking behaviour and attitudes towards smoking when investigating smokers reactions to smoking-related stimuli during abstinence. It is the intention of this thesis to gather data on smokers motivation to smoke, in addition to demographic data, and to investigate the relationship of these to the objective measures to be used in subsequent investigations.

One factor that may have an important role in smokers' reaction to abstinence and their processing of smoking-related stimuli is motivation to smoke. This measure has been used in various investigations of smokers' reactions to stress and smoking behaviour (see Chapter Three). For example, West and Russell (1985) found that scores on the 'dependent' sub-scale of the SMQ significantly predicted withdrawal severity following 24 hours of smoking abstinence. Parrott (1995) studied stress modulation in cigarette smokers and used an 18-item version of the SMQ. The 'sedative' sub-scale of the measure was used to identify smokers who smoked to reduce negative affect, and the 'stimulant' sub-scale was used to identify smokers who smoked for stimulation. The results suggested that the 'sedative' sub-scale of the SMQ was significantly related to the degree of stress modulation in smokers. Thus, the SMQ has been demonstrated to be useful to the extent that its specific sub-scales are useful predictors of smokers' reactions to stress and smoking abstinence. However, there are several versions of the SMQ available and only a small number of investigations of the internal structure and reliability of the SMQ. Given the limited number of studies into the construct validity and the variety of forms of the SMQ it is necessary to carry out some statistical analyses on the 27-item version of the questionnaire. The aim of this task is to identify the factor structure of the measure and to check the internal reliability of the to-be-found sub-scales. This is carried out in the second part of the chapter.

Another issue that must be addressed in the literature is the nature of smoking-related words used in investigations of abstinent smokers processing of such words. The only published word list that is available is the one used by Gross et al. (1993) also used by Jarvik et al. (1995). The Smoking words used by Johnsen et al. (1997) were not published. There is therefore a requirement to develop a smoking word set that could be used in a UK context. The aim of the next section of the chapter is to identify a viable set of smoking-related word and control word stimuli to be used in subsequent experiments.

4.2 Study 1. The development of a smoking word list

4.2.1 Introduction

In Chapter Two the use of smoking-related words in smoking research was reviewed. Here it was argued that traditional smoking-related stimuli such as the sight and smell of cigarettes, (although being potent stimuli which can bring about changes in behaviour and physiological reactions), are neither adequate nor practical in the investigation of the cognitive processing of smoking-related stimuli. In these circumstances smoking-related words seem to be the most effective and appropriate form of smoking-related stimuli in the context of this thesis.

As was noted, only a small number of studies have used smoking-related words in investigations of smokers' responses to smoking-related stimuli (Litz, 1987; Gross, 1993; Jarvik, 1995; Johnsen, 1997). Consequently, it is necessary to construct a word list because there may be problems with the use of the Gross et al. (1993) word list because some of the words are based upon American English. The full set of smoking words used by Gross et al. (1993) are presented in Table 4.1.

Table 4.1. Gross et al. (1993) smoking-related word list.

Addiction	Hot
Ashes	Match
Burn	Nicotine
Butt	Odor
Cancer	Pack
Carton	Lighter
Cigarette	Paper
Death	Pipe
Filter	Puff
Fire	Smell
Flavor	Smoke
Habit	Tar
Taste	Tobacco

It may be argued that the Gross et al. (1993) word list contains certain words that are unfamiliar to UK smokers, (e.g. 'carton'). Therefore, there may be word frequency issues associated with using a non-UK English word list, and issues of word familiarity resulting from spelling differences. Word frequency is an important factor in word based cognitive tasks such as the Stroop colour naming task. This is because colour naming latency could be increased by words that are unfamiliar to participants (Williams, 1996). Prior to the commencement of this thesis no UK-English smoking-related word list was available. It is therefore sensible to construct a smoking-related word list for use in subsequent investigations.

4.2.2 Method

Participants

Smoking and non-smoking participants were used for the first phase of the study (n=39), comprising 26 smokers and 13 non-smokers. For the second phase of the study 15 smokers and 17 non-smokers were used overall. The smokers had smoked for an average of eight years. Participants for both phases of the study were obtained from an undergraduate population of Middlesex University. They received a course credit for participation.

Materials

The initial generation of a set of smoking-related words was achieved by asking participants to complete a smoking-related words questionnaire (this is presented in Appendix 4.1). The questionnaire required participants to provide as many smoking-related words as possible, (these are presented in Appendix 4.2). Following the initial word list generation phase an additional questionnaire was used to determine ratings for a smaller set of smoking-related words. For the second phase questionnaire (see Appendix 4.3) participants were provided with a list of 39 words and required to rate each word according to whether they thought the word related to smoking. This was carried out using a six point forced response scale.

Procedure

In the first phase of the study participants were asked to draw up a list of words that they judged to be related to smoking (see Appendix 4.1). The participants were given 10 minutes to complete this task, there were no other restrictions applied. This process generated an initial list of 92 smoking-related items. From this list the most common words were included in a second phase questionnaire. These words (presented in Table 4.2, Appendix 4.2) were then judged by a panel of 32 smokers on their relatedness to smoking using a 6-point rating scale, ranging from one; very unrelated to smoking to six; very related to smoking (see Appendix 4.3). For this task, participants were given written instructions on the questionnaire. A time limit of twenty minutes to complete the questionnaire was imposed. All questionnaires were completed individually in a quiet office.

4.2.3 Results

The first phase of the study involved the collection of words related to smoking. From this list only the most common words were included in the second phase of the study. From the second phase word list only those words that were rated greater than 4.5 on the 6-point smoking-relatedness scale were selected for inclusion in the final word list. Table 4.1 shows the statistics for each words' smoking-relatedness. Nominal inspection of the ratings in Table 4.1 shows that both smoker and non-smokers rated the word 'cigarette' as being most related to smoking. Of note is the fact that the word '*cancer*' was rated as being smoking-related with a mean rating of 5.21. However, it was decided to not include this item in the final list as the word '*cancer*', although clearly related to smoking could be considered to be related to other domains of concern, or be considered as a general threat word (MacLeod, 1988). Following the decision not to include '*cancer*' and substitute it with '*bronchitis*' a final list of 20 smoking-related words was obtained.

Table 4.1. Descriptive statistics for smoking-relatedness ratings.

Word	Mean	StDev
Addiction	5.12	1.12
Addict	5.31	0.89
Anxiety	4.31	1.17
Ash	5.25	1.13
Ashtray	5.75	0.63
Bad	4.40	1.47
Bar	4.40	1.36
Bronchitis	4.75	1.29
Butt	5.09	0.97
Cancer	5.21	1.03
Cigarette	5.96	0.17
Coffee	4.80	1.52
Cough	4.84	0.98
Death	4.50	1.34
Dizzy	3.12	1.15
Drag	4.77	1.33
Drinking	4.00	1.39
Eating	3.09	1.48
Fags	5.81	0.47
Guilt	3.31	1.53
Habit	5.06	1.16
Illness	4.50	1.34
Inhale	5.06	1.19
Invade	2.87	1.80
Light	3.59	1.18
Lighter	5.15	0.84
Matches	4.84	0.84
Need	4.53	1.29
Nicotine	6.01	0.78
Puff	5.18	0.82
Relax	3.87	1.45
Shake	2.65	1.26
Smell	4.90	1.25
Smoke	5.53	0.67
Social	4.06	1.48
Stress	4.03	1.16
Tar	5.00	1.13
Tobacco	5.78	0.65
Yellow	3.87	1.43

Scale: 1 = strongly unrelated 6 = strongly related

A control word list was derived from words related to household items. The smoking-related and control words were matched for word length and as closely as possible for individual word frequency. Word frequency counts for the two word lists were obtained using the Oxford Pyscholinguistic Database (Quinlan, 1992) which uses the Kucera-Francis (K-F) word frequency norms. However, due to the fact that not all the smoking-related words had frequency data available for them it was decided to ensure that the mean frequency rating for the two sets of words were as similar as possible. A Chi-square analysis demonstrated an association between frequencies for smoking and household words, (χ^2 (19) = 248.10, p < 0.01).. The final smoking-related and neutral word lists and associated K-F word frequencies are presented in Table 4.3.

Table 4.3. Final word list with Keucera-Francis word frequency counts.

Smoking Words	K-F requency	Household Words	K-F Frequency
SMELL	34	LUNCH	33
NEED	360	DOOR	312
COUGH	7	TOWEL	6
COFFEE	78	SHOWER	15
SMOKE	41	KNIFE	76
INHALE	1	SWITCH	43
CIGARETTE	25	GROCERIES	2
TOBACCO	1	CHIMNEY	7
FAGS	*	SOAP	27
PUFF	1	BOOK	36
ADDICT	1	FLOWER	23
NICOTINE	1	UPSTAIRS	28
MATCHES	12	WASHING	44
BRONCHITIS	*	STAIRCASE	8
DRAG	15	LAMP	18
BUTT	12	SOFA	21
HABIT	23	SPOON	6
ASHTRAY	1	CUSHION	8
LIGHTER	12	BLANKET	30
TAR	12	MOP	3

* = no frequency data available. Note: the words in italics are words similar to the Gross et al. (1993) word list.

4.2.4 Discussion

The aim of this study was to generate a suitable set of smoking-related stimuli. A two-phase approach was adopted and was successful l in generating a viable set of 20 smoking-related words. It is apparent that the obtained word list is very similar to the Gross et al. (1993) word list. Inspection of the italicised smoking words in Table 4.3 shows that 12 out of the 20 words in the present smoking word list match the Gross et al. (1993) list. However, there are a few noticeable differences between the two lists. Firstly, the words *death*, and *cancer* which appear in the Gross et al. (1993) list do not appear in the study one list. As was argued previously, these types of words, although related to smoking, are ambiguous threat words and may therefore be inappropriate smoking-related stimuli. Secondly, the word '*carton*' does not appear in the present study list as this word is not generally used in a UK context, the word pack or packet would be more appropriate.

Finally, the reader may notice that the word 'chimney' appears in the household-related word list. This word could be considered to be related to smoking (e.g. 'smokes like a chimney') however, this word did not appear in the original word list generated by the first panel of smokers, and so was not considered to be smoking-related by this sample of smokers and non-smokers. However, it could be argued that the control word 'chimney' may be construed as being smoking-related by the participants in the subsequent experimental studies and thus have an untoward effect on reaction time scores. In order to obviate this effect all reaction times used for analysis will be based on median scores.

In conclusion, this two-phase development of smoking-related stimuli has resulted in the collection of 20 UK specific items. It is hoped that this word list can be used in subsequent investigations into the processing of smoking-related stimuli in smokers.

4.3 Study 2. The Factorial Validity and Internal Reliability of the Smoking Motivation Questionnaire.

4.3.1 Introduction

Chapter Three reviewed various self-report measures used in smoking research. From this review it is clear that motivation to smoke is not a simple univariate construct. Smokers seem to differ in their styles and motivations to smoke, and as such their motivation to smoke depends on various individual and social variables. In the 1960's investigations of smokers personality had taken a new direction and began focusing on the possibility that smokers had not just one motivation to smoke, i.e. nicotine addiction, but several motivations to smoke, and that smokers self-expressed motivations were legitimate to study. The first investigations of smoking motives were carried out by Tomkins (1966, 1969) based on a model that proposed that there were four types of smoker: positive affect smokers, negative affect smokers, addictive smokers and habitual smokers. In the UK McKennell (1970) argued that previous failures to determine a clear cut smoking personality were brought about by the neglect of that fact that smokers have diverse motives for smoking. Following a content analysis of recorded interviews with smokers, Mc Kennell (1970) prepared a list of 'smoking occasion' items and administered them to smokers and ex-smokers. A factor analysis revealed that there were seven factors: nervous irritation smoking, relaxation smoking, smoking alone, activity accompaniment, food substitution, social smoking and social confidence smoking. This analysis confirmed the hypothesis that smokers held various motivations to smoke, and that these motivations were related to the anxyolitic effects of smoking and that smoking had a social dimension.

An important investigation of the factorial structure of smoking motives was investigated and tested using a 34-item measure deigned to analyse a range of smoking motives by Russell and Patel (1974). They observed that previous analyses of smoking motives had ignored the conscious and unconscious dimensions of smoking and had failed to incorporate psychophysiological, psychopharmacological and behavioural data into theoretical accounts of smoking. Russell and Patel (1974) aimed to compare the previous Horn and McKenell typologies, to expand the Horn-type questionnaire, and to relate findings to a new scheme for classifying smoking of smoking which incorporated a sensory-pharmacological continuum. Six oblique factors emerged from this analysis. These were: psychosocial, indulgent, sensorimotor, stimulation, addictive and automatic smoking. No sedative factor was found. In a later review and replication Costa, Mcrae, and Bosse (1980) conducted an investigation to update the evidence on smoking motivation measures. The original Horn and Waingrow items were administered together with some additional items from Coan (1973) and Coan, (1969; cited in Costa, 1980). In a sample of 1,340 smokers and former smokers factor analyses showed that the Horn and Waingrow structure was generally supported using a 23-item and a 43-item measure, with the Coan (1973) items contributing only one new factor: unpleasant habit. Therefore, several analyses have confirmed the utility of smoking motive questionnaires in identifying smokers motives, and these analyses have supported the argument that there are a core set of motives which can be assumed to be stable attributes of smokers personalities. The consensus from most of the research is that there are six motives or reasons for smoking. These are: stimulation, pleasure, sensorimotor manipulation, habit, negative affect reduction and psychological addiction. Moreover, if stimulation, sensorimotor smoking and pleasure smoking are considered to be subtypes of positive affect smoking then much of the factor analyses of smoking motives conform to the original model proposed by Tomkins (Ikard et al., 1969) which posited the existence of four types of smoking: positive affect smoking, negative affect smoking, habit smoking, and psychological addiction smoking.

The 27-item version of a smoking motivation questionnaire (SMQ) chosen for the present study has items representative of the Tomkins typology, and several other items relating to more social aspects of smoking motives. It has been successfully utilised in investigations of smoking deprivation on performance tasks, where the measure has been used to identify sedative smokers (Parrott, 1995). However, there is a paucity of data on the factor structure of this 27-item measure and no data on its reliability. It is therefore necessary to conduct an analysis of the SMQ structure and its reliability before proceeding to use the measure in planned studies of subgroups of smokers and investigations of the relationship between certain smoking motives and the processing of smoking-related words.

4.3.2 Method

Participants

For the purposes of this study 143 smokers were recruited from an undergraduate population of smokers at Middlesex University. Participants received a course credit for participation. The median age of the sample was 22, the average number of cigarettes smoked per day was 18, and the average number of years the sample had been smoking was seven. Of the total sample 89 participants were female and 31 were male, 23 participants failed to report their sex.

Materials

The 27-item version of the smoking motivation questionnaire was adopted for this analysis. The measure requires participants to rate statements about motivation to on a four point forced choice scale, ranging from 0; no not at all, 1; a little, 2; yes quite a bit, to 3; yes very much so. The measure also obtains smoking demographic data such as age, sex, daily cigarette consumption and the number of years the person has been a smoker. The measure takes approximately 10 minutes to complete. The 27-item SMQ is presented in Appendix 4.4.

Procedure

Participants were administered the questionnaire in a quiet office. They were instructed to read the questionnaire instructions carefully and to complete the measure in their own time, but not to spend too much time on each item. Following completion of the questionnaire participants were thanked and given a course credit for participation.

4.3.3 Results

Prior to formal analyses the data set was screened for univariate normality assumptions. It was found that items 1, 2, 6, 15, 17, 22, 24, 26 were not normally distributed, the histograms for these items are presented in Appendix 4.5. Using a conservative criterion analyses showed that Items 15, and 22 were significantly kurtoic, and Items 1, 2, 6, 17, 24 were significantly skewed, (Skew: S.E. Skew > 0.63, $Z > 3.10$, $p < 0.001$), (Kurtosis: S.E. Kurtosis > 1.25, $Z > 3.10$, $p < 0.001$). The univariate statistics for all 27 items of the SMQ are presented in Table 4.4.

Further justification for the removal of these items from future analyses is based upon frequency of response to the respective questions. For item one ("I get a definite craving for a cigarette when I haven't had one for a while) 74.9% of participants responded 'yes quite a bit' or 'yes very much'. This suggests that a large majority of participants have a craving for cigarettes when they haven't had one for a while. A similar trend was found for Item 24 ("I would find it difficult to go without smoking for as long as a week"), where 79.7% of participants responded 'yes quite a bit' or 'yes very much', suggesting that the majority of participants would find it difficult to stop smoking for as long as a week. For item two ("I light up a cigarette without realising that I still have one burning in the ashtray"), 85.3% of participants responded 'no not at all' or 'a little', and for item 17 ("I find myself smoking without remembering lighting up"), 78.3% of participants responded 'no not at all' or 'a little'.

Table 4.4. Descriptive statistics for responses to the 27-item SMQ

Item	Mean	SD	Skew	Std. error	Kurtosis	Std. error
1	2.10	0.90	-0.66	0.20	-0.52	0.40
2	0.50	0.87	1.66	0.20	1.65	0.40
3	1.76	0.99	-0.22	0.20	-1.03	0.40
4	1.93	0.94	-0.46	0.20	-0.75	0.40
5	1.68	0.96	-0.18	0.20	-0.93	0.40
6	0.57	0.89	1.48	0.20	1.15	0.40
7	2.26	0.87	-0.92	0.20	-0.13	0.40
8	1.29	1.08	0.24	0.20	-1.22	0.40
9	1.37	1.05	0.20	0.20	-1.15	0.40
10	1.25	1.06	0.36	0.20	-1.08	0.40
11	1.32	1.06	0.24	0.20	-1.16	0.40
12	1.52	1.07	-0.03	0.20	-1.24	0.40
13	1.50	0.99	-0.14	0.20	-1.02	0.40
14	2.04	0.98	-0.58	0.20	-0.87	0.40
15	1.28	1.16	1.00	0.20	-1.43	0.40
16	1.00	1.07	-0.15	0.20	-1.03	0.40
17	0.78	0.97	1.00	0.20	-0.11	0.40
18	1.64	0.97	-0.15	0.20	0.95	0.40
19	1.38	1.03	0.14	0.20	-1.12	0.40
20	1.81	0.99	-0.28	0.20	-1.02	0.40
21	1.47	1.05	0.01	0.20	-1.19	0.40
22	0.38	0.74	2.18	0.20	4.39	0.40
23	1.32	1.03	0.18	0.20	-1.14	0.40
24	2.31	0.98	-1.21	0.20	0.21	0.40
25	1.05	0.94	0.44	0.20	-0.82	0.40
26	0.46	0.79	1.68	0.20	2.07	0.40
27	2.03	0.92	-0.39	0.20	-1.05	0.40

This suggests that a large majority of smokers in the sample did not think that these two 'automatic smoking' items applied to their smoking motivation. For item six ("I think I look good with a cigarette"), 64.3% of participants responded 'not at all'. For item 22 ("I feel I look more mature and sophisticated when smoking'), 73.4 of responded 'no not at all', and for item 26 ("I feel more attractive to the opposite sex when smoking"), 68.5% responded 'no not at all'. This finding suggests that the 'smoking for image' items were not valid for this sample of smokers. Finally, 36.4% of the participants responded 'no not at all' to the kurtoic Item 15 (" Smoking helps to keep me going when I am tired").

Following the rejection of the skewed and kurtoic questions 19 items were entered into a factor analysis. Following an initial non-rotated Principal Component Analysis (PCA) several solutions emerged. Whilst the scree plot suggested a one or two factor solution (see Appendix 4.6) five factors emerged from the Eigenvalue >1 method. After examining all three possible interpretations the most parsimonious solution was derived from the Kiaser normalisation method. Having observed that the factors were not correlated (see Table 4.5) an orthogonal PCA varimax rotation was adopted. This final analysis (see Table 4.7) revealed a five-factor solution that accounted for 61.83% of the variance in the data set.

Table 4.5. Component Correlation Matrix.

Factor	Dependent	Psychomotor	Sedative	Habitual	Relaxation
Dependent	1.00				
Psychomotor	-.21	1.00			
Sedative	.22	.00	1.00		
Habitual	.21	.00	.28	1.00	
Relaxation	.30	-.21	.21	.20	1.00

After suppressing the items loading less than 0.45 a clear interpretable solution emerged which fitted previous findings. In total seven items loaded on the first factor (dependence). This factor accounted for 30.75% of the variance in the data set. The component descriptions, cumulative variance and Eigenvalues are given in Table 4.6.

Table 4.6. Component descriptions and cumulative variance.

Factor	Cumulative % variance	Eigenvalue
Dependent	30.75	5.84
Psychomotor	41.21	1.98
Sedative	48.98	1.47
Habitual	55.65	1.26
Relaxation	61.83	1.17

For the second factor (psychomotor) there were four items with significant loadings, accounting for 10.45% of the variance in the data set. Factor three (sedative) had three items loading greater than 0.45, which accounted for 7.77% of the variance and factor four (habitual) comprised two items, which accounted for 6.66% of the variance in the data set. Finally, factor five (relaxation) had three items loading greater than 0.45, and accounted for 6.18 of the variance in the data set.

From Table 4.7 it is clear that Item 13 ("I smoke at certain times of the day") loaded on factor five and factor four. However, on face validity alone it would seem reasonable to include Item 13 in factor four as these items relate to 'habitual' smoking. In order to test the consistency of the resulting five sub-scales of smoking motivation a reliability analysis using Crohnbach's Alpha was performed on each of the factors. Analysis of the 'dependent' component resulted in a very good overall alpha (standardised item $\alpha = 0.81$). Observation of the inter-item correlations for the 'Dependence' factor (see Table 4.8) shows that Item 12 ("When I have run out of cigarettes I find it almost unbearable until I get some more") correlated highest with the other items.

Table 4.7. Rotated component Matrix. Varimax rotation with Kaiser 1 normalisation. Revised SMQ.

	Loadings				
Items	**1**	**2**	**3**	**4**	**5**
I find it difficult to go as long as an hour without smoking	.71				
Smoking helps me to think and concentrate	.68				
I get a definite lift and feel more alert when smoking	.65				
I get a real gnawing hunger to smoke when I haven't smoked for a while	.57				
I get a definite pleasure whenever I smoke	.55				
When I have run out of cigarettes I find it almost unbearable until I get some more	.56				
I am very much aware of the fact when I am not smoking	.48				
I smoke to have something in my hands		.80			
I smoke to have something to put in my mouth		.70			
Handling a cigarette is part of the enjoyment of smoking it		.69			
I smoke automatically without even being aware of it		.55			
I smoke more when I am unhappy			.80		
I smoke more when I am worried about something			.78		
I smoke more when I am angry about something			.73		
I have developed a regular pattern of smoking				.80	
I smoke according to a regular routine				.76	
I like a cigarette best when I am having a quite rest					.83
I want to smoke most when I am comfortable and relaxed					.72
I smoke at certain times of the day				.45	.49

Values < 0.45 were suppressed.

As can be seen from Table 4.8 Item 23 ("I am very much aware of the fact when I am not smoking") shows the smallest relationship to the other variables. Furthermore, an alpha if item deleted analysis shows that the internal reliability of the scale would be slightly improved if this item were removed. However, as the improvement is only marginal it was decided that this item should remain in the scale.

Table 4.8. Reliability analysis for the dependent smoking factor. Revised SMQ

Item	Item-Total Correlation	α deleted
I find it difficult to go as long as an hour without smoking	.55	.78
Smoking helps me to think and concentrate	.52	.79
I get a definite lift and feel more alert when smoking	.64	.77
I get a real gnawing hunger to smoke when I haven't smoked for a while	.55	.78
I get a definite pleasure whenever I smoke	.59	.77
When I have run out of cigarettes I find it almost unbearable until I get some more	.66	.76
I am very much aware of the fact when I am not smoking	.33	.82

Analysis of the 'Psychomotor' factor resulted in a good internal reliability (standardised item α = 0.74). Although the internal consistency is not as strong for this scale as for the 'dependent' smoking factor all of the items are highly correlated (see Table 4.9). Furthermore, an alpha if item deleted analysis shows that all of the items are contributing to the scale.

Table 4.9. Reliability analysis for the psychomotor smoking factor. Revised SMQ.

Item	Item-Total Correlation	α deleted
I smoke to have something in my hands	.52	.69
I smoke to have something to put in my mouth	.48	.71
Handling a cigarette is part of the enjoyment of smoking it	.64	.62
I smoke automatically without even being aware of it	.50	.70

Analysis of the 'Sedative' factor resulted in a good overall alpha reliability (standardised item α = 0.73), and (see Table 4.10) all the items are highly correlated. The alpha if item deleted analysis reveals that all the items are contributing to the internal consistency of the factor.

Table 4.10. Reliability analysis for the sedative smoking factor. Revised SMQ.

Item	Item-Total Correlation	α deleted
I smoke more when I am unhappy	.59	.61
I smoke more when I am worried about something	.56	.64
I smoke more when I am angry about something	.52	.69

For the analysis of the 'habitual' factor item 13 "I smoke at certain times of the day' was included in the factor in order to evaluate the internal consistency of the factor with its inclusion. Alpha analysis revealed an acceptable overall alpha reliability (standardised item $\alpha = 0.69$). However, from inspection of Table 4.10 it can be seen that item 13 is not highly correlated with other items in the factor. Moreover, an alpha if item deleted reveals that the overall alpha would be improved if this item was removed. However, as this improvement is marginal it was decided to not remove item 13 from the scale.

Table 4.10. Reliability analysis for the habitual smoking component. Revised SMQ.

Item	Item-Total Correlation	α deleted
I have developed a regular pattern of smoking	.56	.51
I smoke according to a regular routine	.53	.55
I smoke at certain times of the day	.41	.70

As the remaining factor was of a two-item format Cronbach's alpha analyses were conducted without alpha if item deleted statistics. The reliability of the relaxation component was reasonable (Standardised item $\alpha = .69$), with respect to the number of items in the analysis.

4.3.4 Discussion

The aim of the present study was to develop a self-report measure of smokers' motivation to smoke. A literature review showed that several versions of the SMQ existed. A 27-item version, originally developed by Tomkins (1966), and later modified by West and Russell (1985), and used by Parrott (1995) was selected for analysis. Following the collection of 143 questionnaires the data were subjected to factorial and internal reliability analyses.

Following univariate analyses a clearly interpretable five-factor solution emerged. After internal reliability analyses it was found that all five factors had reasonable to very good Chronbach's Alphas. Consequently no items were removed and a final 19-item scale produced.

The five factor solution found in the present study is similar to those reported by previous researchers (Russell et al., 1974; West and Russell, 1985). In particular, Russell et al. (1974) used a 34-item measure of smoking motivation and found six factors: psychosocial, indulgent, sensorimotor, stimulation, addictive and automatic smoking. However, the present study did not support an automatic smoking factor, but one 'automatic' item from the Russell et al. (1974) scale was retained in a psychomotor factor ('I smoke automatically without being aware of it'). Furthermore, following rotation and reliability analysis it was found that two items which loaded on a sensorimotor factor in the Russell et al. (1974) study were split between a psychomotor and habitual factor in the present study. Also in the present study the item ('I smoke to have something to put in my mouth') loaded on a psychomotor factor (.70) and the item ('I smoke according to a regular routine') loaded on a habitual factor (.76). These loadings are high, and reliability analysis demonstrated good Alphas for the two factors. Analysis also revealed that two 'stimulation' items (smoking helps me to think and concentrate', ' I get a definite lift and feel more alert when smoking') and two 'addictive' items ('when I have run out of cigarettes I find I almost unbearable until I get some more', ' I am very much aware of the fact when I am not smoking') in the Russell et al. (1974) study all loaded onto the 'dependent' factor in the present study. Finally, two 'indulgent' items from the Russell et al. (1974) study ('I want to smoke most when I am comfortable and relaxed, and 'I like a cigarette best when I am having a quiet rest') both loaded on a 'relaxation' factor in the present study. This confirms the finding that smokers smoke indulgently or when in a positive mood. Contrary to Russell et al. (1974) a sedative factor emerged from the present analysis, comprising three highly loading items related to smoking to modify negative affect. This finding is line with other studies (Ikard et al., 1969; Coan, 1969 and McKennell, 1970). It is also in line with Tomkins' general model that smoking serves to manage negative affect.

The fact that there are some differences in factor structures between the present study and Russell et al. (1974) is partly due to the removal of some items because of serious skew and kurtosis problems. This was necessary because these items were responded to in the same way by most of the participants. For example, for Item 6, ("I think I look good with a cigarette") 64.3% of responses were rated 0 ('no not at all'). Similar responses were obtained for item 22 (" I feel I look more mature and sophisticated when smoking") and 26 ("I feel more attractive to the opposite sex when smoking"). Thus, not only do these items not measure smoking motivation, but they are likely to yield spurious correlations that will effect the subsequent PCA. Similar findings were reported by West and Russell, (1985) who found that participants in their study responded to 'image' items with mostly zero ('no not at all') responses. Other items in the 27-item scale were also found to be problematic. It is probably the case that all smokers would crave a cigarette when they haven't had one for a while (Item one), and most smokers would find it difficult to go without smoking for as long as a week (Item 24). Finally, the 'automatic' type smoking Items 2 (" I light up a cigarette without realising that I still have one burning in the ashtray") and 17 ("I find myself smoking without remembering lighting up") produced significantly skewed responses. These suggest that smokers in the sample did not consider automatic type smoking to be a significant factor. More contemporary analyses of smoking motivation have revealed that smoking for psychological image is supported as a valid smoking motives in younger smokers (aged 11) but not in smokers aged 13 and above (Stanton, Mahalski, McGee, and Silva, 1993). Furthermore, relaxation smoking and pleasure smoking show a high degree of consistency among younger aged smokers (Stanton, et al., 1993). Convergent validity studies have also confirmed that habitual smoking, pleasure smoking, and addictive type smoking all have sound discriminant validity (Tate and Stanton, 1990). There is also evidence that younger smokers may differ from older smokers in their motivations to smoke. A study by Kiltzke, Irwin, Lombardo and Christoff (1990) analysed self-monitored smoking motives in 73 undergraduates (aged 18-23) and found that positive affect smoking or pleasurable smoking was the most frequently reported reason for smoking and sedative smoking was the least reported. This suggests that younger smokers may differ from older smokers in terms of those motives that are valid for their circumstances or age group. It also suggests that smoking motives are not stable attributes of smoker and that they can change over a smoking career. In the context of the present study it was found that automatic and psychological image smoking was not a valid a smoking motive. Suggesting that age did play a role in the findings.

In summary, this analysis supports a five-factor solution for the SMQ. The final factor structure is consistent with the work of Ikard et al. (1973) and Russell et al. (1974). The modified version of the Russell et al. (1974) scale used by West and Russell (1985) also bears a close resemblance to the findings of the present study. The modified West and Russell scale was made up of five factors: (1) Dependent (2) Automatic (3) Indulgent (4) Sedative and (5) Stimulant. The findings of the present study are also consistent with a similar 23-item version of the scale called the Horn-Waingrow Scale (Ikard, Green and Horn, 1969) which consisted of six similar factors: (1) Habitual smoking (2) Addictive smoking (3) Negative affect reduction (4) Pleasurable smoking (5) Stimulation smoking, and (6) Sensorimotor or psychomotor smoking.

In conclusion, the five extracted sub-scales, comprising 19 items constitutes a reliable and coherent measure of smoking motivation. The final 19-item version of the SMQ is presented in Appendix 4.7.

4.4 General Discussion

The initial aim of this chapter was to generate a set of smoking stimuli that could be employed in subsequent cognitive bias research. As the intention was to use the Stroop and Dot-probe protocols a word list was developed which identified stimuli that had strong smoking associations. This was followed by the selection of control stimuli (household items) which were matched for frequency and word length. Moreover, it was found that the author's word list bared a close resemblance to the Gross et al. (1993) word list. This finding corroborates the word list generated and suggests that it is a coherent and valid set of smoking-related words.

A further aim of this chapter was to investigate the structure and reliability of the smoking motivation questionnaire. This measure has been used in various studies of smokers response to stress (Parrott, 1995), and to identify smoking motivations among smokers (West, 1985). It was argued that the SMQ may be useful in investigations of smokers processing of smoking-related stimuli. However, it was noted that there little data on the SMQ's factor structure and internal reliability. Therefore, it was decided to analyse the 27-Item version of the scale. A factor analysis and reliability analysis of the 27-item SMQ revealed a stable five factor 19-item measure of smoking motivation. In conclusion, the validity of a set of smoking-related words, and the validity and reliability of a self-report measure of smoking motivation has been investigated and confirmed. Moreover, a factor analysis and reliability analysis of the SMQ derived a revised SMQ scale. The following chapters will now systematically investigate the reactions of smokers to smoking-related words and evaluate the effect of abstinence on self-reported cravings, and state anxiety and evaluate the relationship between smoking motivation sub-scales, smoking tolerance (as indexed by the FTQ), craving and anxiety.

Chapter Five

Study Three

Processing of Smoking-Related Words in Smokers and Non-Smokers

5.1 Introduction

Chapter Three highlighted the role of smoking-related stimuli in smoking behaviour and reviewed the range of subjective and objective measures used to study smoking behaviour. Chapter Four presented a study that generated a set of smoking-related words to be used in experiments investigating the processing of such stimuli by smokers. It is the aim of this chapter to investigate the role of smoking-related stimuli in smoking behaviour. In order to measure the information-processing tendencies of smokers (and the impact of smoking-related words) it is necessary to evaluate responses to individual smoking-related stimuli that are not contaminated by verbal reports. To this end the allocation of information processing resources can be investigated by experimental techniques used to study cognitive bias (MacLeod, Mathews & Tata, 1986; Eysenck, 1992a). Such measures may elucidate the impact of smoking-related stimuli on the smoker's cognitive system and their cognitive style. The protocol often adopted when studying cognitive bias is the Stroop task. This task, developed by Stroop (1935) measures the speed of colour naming in congruent and incongruent cases. Stroop found that the speed of naming the colour in which words were printed was much slower when the words colour names were incongruent with their ink colour.

Since this finding Stroop's paradigm has been modified, so as to study cognitive processing in anxiety (Mathews, 1985; Dawkins, 1989; Mogg, 1989; Mathews, 1993; Mathews, 1990ab), phobia (Watts, 1986; Mattia, 1993; Barker, 1997) anorexia nervosa (Channon, 1988) and various psychopathologies (Mattia, Heimberg & Hope, 1993; Barker & Robertson, 1997; see Williams et al., 1996 for a review of studies).

These studies have modified the standard Stroop task by using stimuli that are relevant to the concerns of the particular participants being studied. The emotionally relevant stimuli are presented on cards in various colours. The participant's task is to name the colour that each stimulus word is presented in and reaction times for emotions words and control words are measured. When colour naming for the critical stimulus words is slower than that for controls words, it is hypothesised to be the consequence of additional cognitive processing. That is, it is predicted that because participants are unable to ignore the meaning of the stimulus word the colour naming reaction time is slower.

Only three studies to date have used the modified Stroop to measure cognitive processing in smokers. Gross, Jarvik and Rosenblatt (1993) examined the effect of overnight abstinence on the processing of smoking-related words using a card-based form of the modified Stroop task. Smoking words and neutral words were presented on separate cards using red, green, blue and black colours. Participants were required to colour name each set of words. The time taken to colour name each word set was examined for evidence of Stroop interference, and it was found that abstinent smokers colour-named smoking words slower than control words. This finding was interpreted as evidence for a content-specific shift in cognitive focus in abstinent smokers. Johnsen, Thayer, Laberg and Abjornsen (1997) used a dual response Stroop task to study cognitive processing in abstinent smokers, active smokers and non-smokers. The main task was for participants to colour name each word trial when it was presented on a computer screen. A secondary task required participants to press a key on a computer keyboard that corresponded to the colour of the word presented. This latter task was included in order to increase the difficulty of the task. In contrast to Gross et al. (1993) it was found that active smokers had longer verbal reaction times for smoking words compared to abstinent smokers. This suggested that the active smokers were exhibiting a stronger cognitive bias for smoking words compared to active smokers.

A study by Kassel and Shiffman (1997) tested the hypothesis that the anxiolytic effects of cigarette smoking are cognitively mediated and depend on a benign distracter. Smokers levels of anxiety were observed under smoking (distraction vs. no distraction) and non-smoking (distraction vs. no distraction) conditions. A modified Stroop was used to measure what the participants were thinking about during the distraction / no distraction periods. In this study it was hypothesised that the Stroop would index which semantic networks had been activated during the experimental period. For the Stroop task participants were presented with smoking, body-related, art-related and anxiety-related words on a computer screen. Each word was presented singularly and participants were instructed to name the colour of the word out loud and to press one of four marked computer keys that corresponded to the colour red, green, yellow or blue; only reaction times for key-press responses were recorded. It was found that smoking in conjunction with distraction led to a reduction in anxiety. The results also indicated that all participants showed Stroop interference for body-related and anxiety-related words. No interference effect was observed for art-related words. However, the Stroop data for smoking words did not support the hypothesis that deprived anxious smokers would respond differentially to smoking words. The authors suggest that this null finding might have been due to the failure of the experimental manipulations to activate semantic networks related to smoking at a level required to cause interference effects. In addition, the methodology was such that smoking words were intermingled with target words from other domains, and this may also have interfered with the Stroop effect.

Finally, a small number of related studies have investigated the processing of alcohol-related words in users and abusers of alcohol using a modified Stroop task (Johnsen, Laberg, Cox, Vaksdal & Hugdahl, 1994; Setter, Ackermann, Bizer, Straube & Mann, 1995). The Johnsen et al. (1994) and Setter et al. (1995) studies both found a Stroop effect for alcohol-related words. However, Bauer and Cox (1998) found that both groups were equally distracted by alcohol-related words. This finding suggests that alcohol-related words are distracting for drinkers in general and not just abusers, and does not support the findings of other studies. Thus, as with the smoking research there are inconsistencies in the findings from alcohol studies. In summary, the evidence that substance users show bias for words related to their substance of use or abuse is growing but a conclusive picture has not been achieved.

As this review has noted, various Stroop protocols have been used to study the cognitive styles of smokers and alcohol users. This variation may in part explain the inconsistencies that are apparent in the research. Gross et al. (1993) used a standard card-based protocol and found differential processing for smoking words following abstinence. Johnsen et al. (1997) used a manual and vocal response single trial protocol and found an opposite pattern of results, whereby only active smokers demonstrated interference for smoking words. Lastly, Kassel et al. (1997) used a manual and vocal response Stroop as a subsidiary measure and found no differential processing in deprived smokers. Thus, the inconsistency may be explained by different protocols.

A further issue of protocol difference concerns the format of the stimuli presented. In particular, card-based forms of the task have been criticised for being more susceptible to interstimulus rumination than presentations of single words (Lavy & van den Hout, 1993). Thus, it may be argued that card-based Stroop tasks are disadvantaged because they allow participants to dwell more on the word meaning. Any Stroop interference observed when using this form of the task could be due to post-attentional rumination, and so may not directly measure selective attention. Furthermore, card-based forms of the task produce total colour naming latencies for word sets and do not provide reaction time data for individual words. By contrast computerised forms of the Stroop task have some distinct advantages over card-based blocked word formats. Computerised single trial Stroop tasks have been used successfully in studies of fasting (Lavy & van den Hout, 1993) panic disorder (McNally, Reiman & Kim, 1990) and phobia (Mattia, 1993; Barker, 1997). In this variant of the task each stimulus word is presented on a computer screen and participants are required to colour name each stimulus. Reaction times may be based on vocal responses recorded by microphone or appropriately labeled response keys. Findings from studies using this form of the modified Stroop confirm that the task results in Stroop interference effects (Williams, 1996). This is may be due to the fact that single trial forms do not allow for post-attention rumination (Lavy & van den Hout, 1993).

In the light of these findings it is argued that a single trial Stroop modification is the best choice for this first investigation into abstinence. The modification adopted for this study will involve the presentation of stimulus words on a computer screen with response latencies obtained via designated keyboard keys. This modification allows for individual reaction times to be derived for each stimulus presentation, which it is hoped achieves greater accuracy than blocked word formats. Furthermore, an incongruent /congruent design was chosen because it allows for reaction times to be obtained under conditions in which participants are required to evaluate the critical stimulus and match its colour to a colour word presented in a different location. This form of the Stroop task is similar to that used by Gatti and Egeth (1978; cited in Fox, 1993) who presented a centrally-fixed colour patch with distracting information in spatially different locations. It was found that reaction times to name the colour patches were slower when displaced words were incompatible colour words. Thus there is evidence to support the argument that the Stroop design chosen for the present study is valid.

In summary, while there has been some research into the cognitive processing of smokers, non-smokers, and alcohol users, this review shows that a breadth of understanding has not been obtained. The aim of the present study is to build upon previous smoking research. This is to be carried out through the application of a computerised modified version of the Stroop task to study dependent smokers and non-smokers. Although previous research has provided inconsistent findings it is hypothesised that smoking status will predict latencies on smoking words only.

Finally, it has been found that smokers are more anxious than non-smokers (Schneider & Houston, 1970; Spielberger, 1986; Hughes, Hatsukami, Mitchell & Dahlgren, 1986; Patton, Barnes & Murray, 1993). Thus, it may be expected that the smokers in this study would be more anxious than non-smokers. Since there is evidence that higher levels of State anxiety and Trait anxiety in 'normals' is associated with increased Stroop interference for distracting stimuli (Mathews et al., 1990, 1996; Mogg, 1990), this study will also measure anxiety in smokers and non-smokers and evaluate the effect of anxiety on word processing. Other measures will be restricted to the use of the Fagerström Tolerance Questionnaire (FTQ) to determine levels of dependence in smokers.

5.2 Method

Participants

A total of 57 participants took part in the study, comprising 29 non-smokers and 28 smokers. The FTQ (see Appendix 5.1) was administered to assess physical dependence among the smokers (Fagerström, 1989). A mean FTQ score of 6.0 (SD = 1.90, range =7) revealed that the smoking group consisted of dependent smokers (Physicians, 2000). Non-smokers were defined as individuals who were not currently smoking and had been abstinent for a minimum of one year. There were 20 males and 37 females in the sample, and the median age of the participants was 28.5. Participants were psychology undergraduates from Middlesex University. Each participant received a course credit for participation.

Design

A mixed three-way design was employed in which smokers and non-smokers (between subjects) were presented with smoking and neutral words (within subjects) in congruent and incongruent colours (within subjects). The dependent variable was the amount of time (as measured in seconds) it took for the participants to decide whether a colour word matched the colour used to present smoking and control words. Randomisation methods are discussed in the Stroop section. State anxiety and trait anxiety scores were measured as further predictors of cognitive bias.

Materials

Stimuli

The smoking-related words and control words presented in Chapter Four were used as stimuli (see Table 4.3). The stimuli were presented using an IBM 486 desktop computer and a high resolution Zenith colour monitor. Responses were recorded via designated keyboard keys. The experimental software (Micro Experimental Laboratory) was programmed to deliver the stimulus presentation, the stimulus duration, the colour of the stimulus and record the reaction time latencies (Tools, 1990). Smoking dependence was measured by the FTQ and the Spielberger State-Trait Anxiety Inventory was used to measure anxiety.

Stroop trials

In this modified Stroop items were presented individually. On each trial a fixation point was presented, and then two words were presented simultaneously on the screen, one at the top of the screen and the other below it, subtending at an angle of 30 degrees. A colour word (e.g. BLUE) always appeared at the bottom location, in upper case and always in white. The word stimuli (always in upper case) were presented in the following colours: RED, GREEN, YELLOW, PINK and BLUE. There were two conditions; a congruent condition included a colour word at the bottom that was congruent with the colour of the ink used for the stimulus word at the top. The incongruent condition was the opposite. Both words remained on the screen until the participant made a response via designated computer keyboard keys. These were; 'S' for "same", and 'K' for "different". The inter-stimulus interval period was 1000 milliseconds. The presentation software recorded the reaction time latency for each trial that was operationally defined as the interval between stimulus presentation and keyboard response. For each test the participants completed 15 practice trials of neutral words, and after 30 seconds rest a block of 40 fully randomised experimental trials were completed. The presentation software reminded participants of the designated responses before the experimental block of trials were carried out.

State and Trait anxiety measures

The Spielberger Anxiety Questionnaire (forms STAI Y-1 and STAI Y-2; (Spielberger Gotusch, Loshene, Vagg and Jacobs, 1983) was used to measure anxiety in smokers and non-smokers. This measure comprises 40 items, 20 items concerned with state anxiety 'how you feel right now' and 20 items measuring trait anxiety 'how you generally feel'. Each item is evaluated on a 1-4 scale where 1= not at all, 2 = somewhat 3 = moderately so and 4 = very much so. Forms Y-1 and Y-2 are presented in Appendix 5.3. Each item is given a weighted score of one to four. A rating of four indicates high levels of anxiety for the ten state anxiety items and eleven trait anxiety items. A high rating for the remaining state anxiety and trait anxiety items indicates the absence of anxiety. The scoring of the inventory involves reversing the scoring for the anxiety absent items and then summing the weighted responses for the state anxiety and trait anxiety scales. This procedure derives state anxiety and trait anxiety scores for each participant. Scores for the state anxiety and trait anxiety scales can vary from a minimum of 20 to a maximum of 80 (Spielberger et al., 1983). The state anxiety and trait anxiety norms for College students are presented in Table 5.1 (Spielberger et al., 1983).

Table 5.1. State anxiety and trait anxiety norms.

	College Students	
	Female (N = 531)	Male (N = 324)
State anxiety		
Mean	38.76	36.47
SD	11.95	10.02
Alpha	0.93	0.91
Trait anxiety		
Mean	40.40	38.30
SD	10.15	9.18
Alpha	0.91	0.90

Procedure

Testing was conducted in a single session. Participants initially completed the Spielberger state trait anxiety scales. They were then seated 0.5m from a VDU screen with comfortable access to the designated response keys. Participants were then given the following instructions for the Stroop test on the screen.

> *In this experiment you will be asked to decide whether or not the colour word in the lower half of the screen refers to the colour ink used to display the non-colour word in the top half of the screen. If you judge them to be the same then press the 'S' key. If you judge them to be different then press the 'K' key.*

Participants were told that speed and accuracy were important criteria for the test. Following clarification of the instructions participants carried out a block of practice trials, followed by a block of experimental trials. At the end of the session all smokers completed the FTQ questionnaire. Following completion of the tasks participants were debriefed and thanked for their participation.

5.3 Results

Stroop data

Prior to analysis smoking and control word reaction time distributions were examined for univariate normality, (See Appendix 5.2). It was found that both sets of words were positively skewed (Smoking words, $Z = 4.18$, $p < 0.001$; Control words, $Z = 4.34$, $p <$

0.001). In order to identify outliers in the data reaction times were converted into to Z-scores. Following this procedure three participants scores were removed from further analyses (criterion, $Z = 3.14$, $p < 0.001$). This resulted in a normally distributed data set for 27 smokers and 27 non-smokers.

Stroop analysis

Reaction time scores for the Stroop task are presented in Table 5.2. Overall assessment of the reaction times suggests that there are no differences between the levels of the factors. A mixed three way ANOVA showed that an overall Stroop interference effect had not been found ($F(1,52) = 1.96$, $MSe = 1.47$, $p > 0.05$). As can be seen from Table 5.2 overall reaction times for incongruent trials were not slower compared to congruent trials. Consequently further statistical analyses should be interpreted cautiously.

Table 5.2. Reaction times for congruent and incongruent word trials by group.

Word Type	Smokers		Non-Smokers		All	
	Mean	SD	Mean	SD	Mean	SD
Smoking						
Congruent	0.935	0.202	0.926	0.162	0.931	0.182
Incongruent	0.937	0.189	0.918	0.192	0.914	0.226
All	0.936	0.181	0.909	0.196	0.922	0.188
Control						
Congruent	0.962	0.184	0.922	0.187	0.942	0.185
Incongruent	0.924	0.185	0.901	0.171	0.913	0.177
All	0.943	0.170	0.912	0.171	0.928	0.169
Congruent	0.949	0.186	0.924	0.166	0.936	0.175
Incongruent	0.931	0.184	0.896	0.199	0.914	0.191
All	0.940	0.172	0.910	0.176	0.925	0.173

Reaction times are in seconds.

It was found that there was no significant main effect of word type ($F(1,52) = 0.18$, $MSe = 8.31$, $p > 0.05$) and the main effect of smoking status was not significant ($F(1,52) = 0.38$, $MSe = 0.122$, $p > 0.05$). Furthermore, the interaction involving the congruence factor, word type and smoking status was found to be non-significant ($F(1,52) = 1.39$, $MSe = 7.47$, $p > 0.05$). In summary, this analysis indicates that overall reaction times for congruent and incongruent trials did not significantly differ, and incongruent trials involving smoking-related words did not result in the predicted different responses in the smokers.

Anxiety measures

The smokers and non-smokers state trait anxiety scores are presented in Table 5.3. With reference to the STAI norms presented in Table 5.1 it can be seen that the mean state anxiety score, and the mean trait anxiety score for the smokers is above the norm for college students. Non-smokers had state trait anxiety scores that are close to college student norms (Spielberger 1983). Analyses revealed that smokers had higher state anxiety than non-smokers ($t(52) = -1.96$, $p \leq 0.05$). The smoking group had higher trait anxiety scores, but these were not statistically significant from non-smokers ($t(52) = -1.48$, $p > 0.05$).

Table 5.3. Anxiety scores for smokers and non-smokers (N=29).

Variable	Mean	SD
State anxiety		
smokers	41.07	8.72
non-smokers	36.29	9.10
Trait anxiety		
smokers	45.44	7.93
non-smokers	41.70	10.46

Finally, an analysis of the relationship between anxiety scores and reaction time responses was performed for smokers and non-smokers in order to evaluate the effect of anxiety on reaction time performance; the correlations for smokers are presented in Table 5.4. There were no significant correlations between smoking and neutral word reaction times and state or trait anxiety. However, the correlation between trait anxiety and reaction times for congruent smoking words approached significance (p=0.06, one tailed).

Table 5.4.Correlations among Stroop reaction times and anxiety scores. Smokers only.

	Variable	1	2	3	4	5	6
1	Smoking Congruent	X					
2	Smoking Incongruent	.71*	X				
3	Control Congruent	.85*	.68*	X			
4	Control Incongruent	.69*	.93*	.69*	X		
5	State anxiety	-.07	-.12	-.26	-.16	X	
6	Trait anxiety	-.30	-.15	-.16	-.19	.49*	X

* = significant at the 0.01 level.

The correlations for non-smokers are presented in Table 5.5. None of the correlations between state or trait anxiety and Stroop reaction times were significant. Furthermore, the correlation between trait anxiety and the congruent smoking words (which approached significance in the smoking group) was not evident in the non-smokers. The most surprising result from this study was the failure to elicit a Stroop interference effect. Although this is not the purpose of the thesis some possible explanations are required. The nature of the relationship in the smokers was such that high trait anxiety was associated with reaction times. However, no Stroop effect was observed in the non-smokers so it is only possible to conclude that anxiety had a general effect on reaction times in the smoking group and did not contribute to a Stroop effect.

Table 5.5. Correlations among Stroop reaction times and anxiety scores. Non-smokers only.

Variable	1	2	3	4	5	6
1 Smoking Congruent	1.00					
2 Smoking Incongruent	.71*	1.00				
3 Control Congruent	.81*	.68*	1.00			
4 Control Incongruent	.80*	.69*	.81*	1.00		
5 State anxiety	.14	.05	.10	-.03	1.00	
6 Trait anxiety	-.04	-.18	-.00	-.14	.80*	1.00

* = significant at the 0.01 level.

5.4 Discussion

The aims of this study were to build on previous research into smokers' and non-smokers' processing of smoking-related stimuli. As a further consideration anxiety and dependency scores were measured in order to examine the relationship between these variables and word processing performance. The Stroop data did not reveal any significant differential processing in smokers and non-smokers, and the pattern of data suggested that the presentation of incongruent and congruent trials did not produce an interference effect.

As discussed earlier, the single trial computerised form of the Stroop task has been shown to produce reliable effects. Therefore, it was unexpected that this study did not produce the predicted main effect for congruence. One possible explanation of the null finding comes from Williams' (1986) review of the Stroop task in the context of psychopathology. He has suggested that null findings in Stroop tasks may be due to the ability of participants to strategically override Stroop interference effects. One possible example of this is reported by Martin et al. (1991). They compared individuals with high and low trait anxiety on the colour naming of anxiety-related words. The study failed to find any Stroop interference in the groups. Furthermore, there is evidence that non-clinical samples are particularly able to override the tendency to be distracted by emotionally valent stimuli (Mathews, 1993). Therefore, it is possible that the participants in the present study adopted an override strategy, thus enabling them to ignore the effect of congruency and the meaning of smoking-related words. An alternative explanation is that the null findings of the present study reflect a statistical anomaly. A further possibility is that the samples were too small to reveal a significant difference. Whatever the case may have been it seems that a replication of the methodology is necessary to provide a fair assessment of the hypothesis under investigation.

As predicted the smokers in this study were found to have higher anxiety scores than non-smokers. The difference found between smokers and non-smokers for trait anxiety may reflect general differences between smokers and non-smokers. Research has shown that smokers are generally more trait anxious than non-smokers (Angst, 1979; Spielberger, 1982). The higher state anxiety scores found in the smokers may reflect situational anxiety. It is possible that some smokers may have been anxious about the nature of their participation in the experiment. However, given that state and trait anxiety are highly correlated (Spielberger, 1983) it is possible that both anxiety measures reflected a higher level of general anxiety in the smokers. This finding is supported by Patton, Barnes and Murray (1993) who examined the relationship between personality and smoking status. They reported that active smokers had significantly higher state anxiety compared to non-smokers. However, the significant differences in State anxiety may also have been due to perceived experimental demands. The smokers who enrolled for the study may have experienced an increase in state anxiety because they were concerned about the nature of the tasks they were asked to perform. It is likely however, that the differences observed between smokers and non-smokers is more a function of an interaction between trait differences and situational anxiety.

Finally, an examination of the relationship between anxiety and reaction times showed that a correlation between anxiety and Stroop reaction times was not significant. However, when comparing smokers with non-smokers the relationship between smoking words and Trait anxiety was found to be stronger for smokers than non-smokers. The nature of the relationship in the smokers was such that high trait anxiety smokers provided slower reaction times overall.

5.5 Conclusions

This study has provided data on smokers' and non-smokers' processing of smoking-related words. Because a Stroop effect was not observed no firm conclusions can be made on group differences in word processing. Therefore, it would be sensible to partially replicate this study prior to concluding that dependent smokers do not show a cognitive bias to smoking related stimuli. A subsidiary aspect of the research which supported previous findings was the prediction that smokers are more anxious than non-smokers. Smokers were found to have higher state and trait anxiety scores compared to non-smokers. This indicates either a high degree of situational anxiety in the smokers or a greater generalised anxiety.

In summary this study failed to find a Stroop interference effect, and failed to detect any differential word processing in smokers. This may have been due to strategic override of Stroop interference, to a statistical aberration, or to a lack of statistical power. In order to progress the understanding of smokers and non-smokers processing of smoking-related stimuli a further study using the same Stroop protocol is required in which smokers are made abstinent and their processing of smoking words is compared to active smokers and non-smokers. The hypothesis that abstinence brings about a preoccupation with smoking and a shift towards smoking-related stimuli is investigated in the next chapter.

Chapter Six

Study Four

Smokers, Abstinent Smokers, and Never-Smokers Processing of Smoking-Related Words

6.1 Introduction

As the findings in the previous chapter failed to replicate a Stroop effect found in numerous other studies it is necessary to test the same hypothesis again. A further aim of this chapter is to derive an understanding of the effects of abstinence on cognitive bias. This chapter presents a study with an experimental design intended to investigate the hypothesis that smokers, abstinent smokers and non-smokers differentially process smoking-related stimuli. As previously noted this expectation is supported by only one study (Gross, 1993), and other studies have not provided consistent data (Johnsen, 1997; Kassel, 1997). Therefore, it is still unclear how abstinent smokers, active smokers, and non-smokers differ in their processing of smoking-related stimuli.

One aspect of the research area that may be of relevance to a study of abstinence concerns sample selection. For example, the only significant finding (Gross et al., 1993) used smokers undergoing treatment for alcohol and drug abuse in a medical center. No details were given concerning the type of treatment the participants were undergoing, or whether they were screened for drug use that might have had effects on cognitive performance and reaction time. Therefore, smoking-related information for such smokers could, according to nodal theories of emotion (Bower, 1981; Bower, 1992) be semantically related to other drug-related information in memory. This is a particular issue for studies that use smoking-related words as an independent variable, and smokers who also use other drugs apart from nicotine. Moreover, many of the words used in the Gross et al. (1993) study could be considered to be associated with smoking and alcohol (e.g. *addiction, habit, taste, smell*).

Therefore, there is a need to replicate the Gross et al. (1993) findings using smokers who have not had a history of problem drug and alcohol use other than nicotine.

A further issue suggesting the need for clarification concerns contradictory findings. The abstinent smokers studied by Johnsen et al. (1997) were enrolled in a smoking cessation programme and had been abstinent for at least three days. It was reported that the abstinent smokers had faster reaction times for smoking words compared to active smokers. Thus, the abstinent smokers in this study are a fundamentally different group to the smokers studied by Gross et al. (1993). Johnsen et al. (1997) argue that the 'abstinent' smokers in their study had experienced a reduction in information processing bias for smoking words as a function of the cessation intervention. The unspecified intervention was argued to have modified the smokers' cognitions to such an extent that they exhibited greater attentional control following treatment. Finally, Kassel et al. (1997) studied smokers who had been deprived for no more than 65 minutes, and failed to find a predicted differential processing of smoking words. In summary, Gross et al. (1993) studied smoking alcoholics and drug abusers, Johnsen et al. (1997) studied abstinent smokers who had received an unspecified smoking cessation intervention, and Kassel et al. (1997) measured Stroop performance after approximately one hour of smoking deprivation. Therefore, it is not possible to draw any firm conclusions from the findings because of the different characteristics of the smoking samples used. It is the intention of this study to examine abstinence effects in smokers without the confounds discussed above.

In addition to self-report craving measures Gross et al. (1993) measured thoughts about cigarettes prompted by performance of the Stroop task using a Likert type scale. This measure was used to determine whether abstinent smokers are consciously aware of their preoccupation with smoking-related stimuli. If they are, then they should report that performing the Stroop task is accompanied by an awareness of their preoccupation. Gross et al. (1993) found that abstinent smokers were not consciously aware of their preoccupation with smoking words and they argued that this finding supports the Stroop measures utility as an indirect and objective measure of cognitive activity. Also, if the effect was caused by confounding measures (drugs and alcohol) then the smokers obviously would not report knowing it was about smoking. This is an important issue for further discussion. If it is the case that abstinent smokers are not aware that they are preoccupied by smoking-related stimuli, but an objective measure of cognitive activity reveals that at an unconscious level they are, then this suggests that there are disassociated processes underlying abstinent smokers' processing of smoking-related words. The present study will gather data on participants' awareness of smoking-related preoccupations being prompted by the Stroop task and provide further data to inform the above argument.

The previous study found that smokers had higher state and trait anxiety scores than non-smokers. As argued, this may have been due to situational anxiety related to perceived experimental demands. However, it is also possible that the higher levels of anxiety observed in the smokers reflected the fact that smokers are more anxious than non-smokers (Spielberger, 1986; Patton et al., 1993). It was also found that trait anxiety was related to word processing in smokers. In the present study there is an opportunity to further evaluate differences in smoker and non-smoker anxiety and to investigate the effect of abstinence on self-reported anxiety and cognitive processing. Hatsukami, Skoog, Huber, and Hughes (1991) showed that cigarette deprivation results in increased anxiety and tension. A similar study by Hughes and Hatsukami (1986) showed that DSM-III symptoms of anxiety increased after smoking cessation. These findings demonstrate that smoking cessation and abstinence effect smokers' self-reported anxiety. Therefore, it is important to evaluate the effect of abstinence on anxiety levels (Broadbent & Broadbent, 1988).

The final aim of this study is to investigate the relationship between anxiety, craving and motivation to smoke related to affect, as measured by the SMQ-sedative and SMQ-relaxation sub-scales. Given that there is evidence that information processing is affected by levels of state and trait anxiety (Williams, 1986) it is reasonable to hypothesise that smokers who experience increased anxiety following smoking abstinence (and who smoke to modulate affect) would show more Stroop interference for smoking-related words. This hypothesis will be investigated through an analysis of the relationship between anxiety, motivation to smoke, cigarette craving and smoking word processing in abstinent smokers.

In summary, several hypotheses are to be investigated in this study. Firstly, it is predicted that abstinent smokers will demonstrate a cognitive bias for smoking-related words. Secondly, it is predicted that abstinence will have a significant effect on subjective desires to smoke, and thoughts about smoking. Finally, it is predicted that abstinence will create a significant increase in state anxiety and that this will be related to motivation to smoke, self-reported craving for cigarettes and Stroop interference for smoking words.

6.2 Method

Participants

A total of 78 participants were recruited from the Middlesex University undergraduate psychology participant pool. They received a course credit for participation. The median age of the smokers was 23 and the median age of the non-smokers was 22. There were 23 abstinent smokers, 22 active smokers and 33 non-smokers

Design

A mixed factorial design was employed in which abstinent smokers, active smokers and non-smokers were presented with smoking and neutral words in congruent and incongruent colours. Abstinent smokers were required not to smoke for a period of six hours, while active smokers smoked normally for the same period. The dependent measure was reaction time to incongruent and congruent trials of smoking-related and neutral words. The modified Stroop task used randomisation and presentation protocols identical to those used in the previous study.

Materials

Stimuli

Smoking and neutral words were used as stimuli. Smoking dependence was measured by the FTQ (see Appendix 5.1) and the Spielberger STAI was used to measure anxiety. CO testing was conducted using a Bedfont Smokerlyzer. To assess smoking motivation the revised 19-item SMQ reported in Chapter Four was employed (see Appendix 4.7). Self-reported craving for cigarettes, thoughts about cigarettes and thoughts about cigarettes prompted by the Stroop task were measured by Likert-type scales ranging from one; 'very much' to nine; 'not at all' (see Appendix 6.1 for craving measures).

Procedure

Each participant was tested individually. Participants arrived for their first session between 0900 and 1100 a.m. They were met by the experimenter who explained the experiment and obtained consent for participation. Following this state anxiety and trait anxiety forms were completed, and measures of craving and thoughts about smoking were obtained. Participants were then randomly allocated to either an abstinent or active smoking condition. If allocated to the abstinent condition they were asked to refrain from smoking for six hours before returning for the second session in the afternoon. Active smokers were told to smoke as normal until the time of their second session. They were also instructed to smoke within one hour of the start of their second session in order that all active smokers were experiencing comparable levels of plasma nicotine. Finally, a breath sample was obtained for Carbon Monoxide (CO) testing.

At session two each participant in the abstinent group was asked if he or she smoked and to provide a breath sample for CO analysis. Active smokers also provided a breath sample for CO analysis to confirm continuous smoking. Non-smokers were tested in a single p.m. session. They were required to complete the state and trait anxiety forms, and then they completed the Stroop task in the same procedural manner as the smokers.

Stroop testing was conducted in a sound attenuated room with controlled lighting conditions. Participants were seated in front of a VDU screen with comfortable access to the designated response keys. Instructions for the Stroop test were identical to instructions given to participants in the Chapter Five. Participants were told that speed and accuracy were important criteria for the test. Following clarification of the instructions participants carried out the block of practice trials followed by the block of experimental trials. Abstinent and active smokers then completed the FTQ, SMQ and self-reported ratings of desire to smoke, craving for cigarettes, and thoughts about smoking prompted by the tasks. Following the completion of all tasks the participants were debriefed and thanked for their participation.

6.3 Results

Participant demographics

A profile of the abstinent and active smoking groups is presented in Table 6.1. Analysis showed a significant difference between the abstinent and active smokers for the number of years they had been smokers ($t\ (15.30) = -2.45$, $p < 0.05$).

Table 6.1. Smoking demographics and dependency scores for abstinent smokers and active smokers.

Group	Variable	Mean	Min	Max	SD
Abstinent Smokers	Cigarettes smoked per day	19.80	7.00	40.00	7.70
	Years smoking*	7.10	1.00	16.00	3.90
	Fagerström Tolerance Score	6.30	2.00	9.00	2.00
Active smokers	Cigarettes smoked per day	17.90	8.00	30.00	6.30
	Years smoking*	13.90	2.00	35.00	9.60
	Fagerström Tolerance Score	6.00	3.00	9.00	1.60

(* = significantly different between abstinent smokers and active smokers)

For the FTQ a score of 11 denotes the highest level of dependence.

No significant differences for the number of cigarettes smoked per day were found (t (42) = 0.10, p > 0.05) and FTQ scores did not differ between the abstinent and active smokers (t (42) = -0.11, p > 0.05). Both groups had FTQ scores that conformed to a dependent smokers profile.

Expired air carbon monoxide readings

Carbon Monoxide readings were obtained to verify abstinence and continuous smoking. Any participant who reported smoking was excluded from the analysis. A fifty- percent reduction in CO ppm was used as a criteria for verification of abstinence. A total of three participants were excluded from further analysis. Two participants had CO readings higher than their session one values, and one participant reported having smoked during the abstinence period. This participants CO reading verified this self-report. Descriptive statistics for CO the remaining participants readings are presented in Table 6.2.

Table 6.2. CO scores for abstinent and active smokers.

	Mean CO	SD	Min	Max
Session One				
Abstinent smokers	13.09	8.27	2.00	35.00
Active smokers	16.23	9.24	3.00	38.00
Session two				
Abstinent smokers	7.10	5.87	1.00	21.00
Active smokers	18.57	10.10	7.00	38.00

A repeated measures ANOVA was performed on the abstinent and active smokers data to examine the effect of abstinence on carbon monoxide levels. No main effect of session was found ($F(1,39) = 3.61$, $MSe = 18.53$, $p > 0.05$). A predicted significant interaction between session and smoking status was found ($F(1,39) = 18.96$, $MSe = 18.53$, $p < 0.05$) suggesting that the abstinent smokers had not smoked. Simple main effects analyses by session showed that the abstinent group did not differ significantly from the active group at session one ($F(1,40) = 1.37$, $MSe = 75.29$, $p > 0.05$), with a mean CO of 13.09 ppm[3] for the abstinent group, and a mean CO of 16.23 ppm for the active smoking group. However CO levels were significantly lower in the abstinent group at session two ($F(1,39) = 19.49$, $MSe = 69.15$, $p < 0.001$). These findings corroborate self-reports of abstinence during the six hour period.

Stroop analysis

Prior to analysis of the Stroop data smoking and control word reaction time distributions were examined for univariate normality, (See Appendix 6.2). As with the previous study reaction time scores were first transformed into Z scores. A criteria of $Z > 3.10$, $p < .001$, (two tailed) was adopted to identify univariate outliers in the distributions. None of the participants' reaction time scores were outside the Z score criteria range.

For the main analysis a two (congruent / incongruent colour) by two (smoking word / neutral word) by three (abstinent smoker / active smoker / non-smoker) ANOVA was

[3] CO readings are expressed in parts per million, ppm.

performed. This revealed a main effect for congruence (F (1,75) = 38.91, *MSe* = 8.48, p< 0.05) showing that reaction times for the incongruent trials were significantly slower than congruent trials. This result is consistent with the design of the Stroop task. However, the analysis revealed that the main effect for word type was not significant (F (1,75) = 0.35, *MSe* = 4.52, p > 0.05) but the main effect for group approached significance (F (1,75) = 2.39, *MSe* = 26.24, p = 0.09). This reflected the fact that across all trials and for both word types the active smokers had slower reaction times compared to abstinent smokers and non-smokers. This difference can be seen in Table 6.3. Furthermore, it can be seen that abstinent smokers demonstrated the quickest reaction times for all trails. However, the ANOVA revealed that the interaction between congruence and word type was not significant (F (1,75) = 0.08, *MSe* = 2,69, p > 0.05) and the three-way interaction involving congruence, word type and smoking status was also not significant (F (2,75) = 0.53, *MSe* = 5.07, p > 0.05). In summary, the analysis of the Stroop data suggested that active smokers processed incongruent smoking word trials slower than abstinent smokers and non-smokers. It was also found that the abstinent smokers processed all trials faster than active smokers and non-smokers. However, the interaction involving congruence, word type and group did not support the hypothesis that abstinent and active smokers differentially process smoking words.

Table 6.3. Reaction times for congruent and incongruent trials of smoking-related and neutral words by smoking status.

Word Type	Abstinent Smokers		Active smokers		Non Smokers		All	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Smoking								
Congruent	0.757	0.140	0.872	0.171	0.815	0.180	0.814	0.170
Incongruent	0.823	0.164	0.946	0.206	0.882	0.197	0.882	0.194
All	0.791	0.143	0.910	0.176	0.849	0.179	0.850	0.172
Control								
Congruent	0.782	0.160	0.856	0.164	0.828	0.168	0.822	0.165
Incongruent	0.819	0.163	0.936	0.184	0.902	0.209	0.887	0.193
All	0.801	0.151	0.897	0.166	0.865	0.182	0.854	0.171
Congruent	0.770	0.145	0.865	0.155	0.822	0.168	0.819	0.160
Incongruent	0.821	0.158	0.941	0.188	0.892	0.198	0.885	0.187
All	0.796	0.143	0.903	0.164	0.857	0.179	0.852	0.168

Reaction times are in seconds.

State and trait anxiety

State anxiety was measured in the three groups at session one and session two and trait anxiety at session one only. Table 6.4 shows that active smokers and non-smokers had almost identical trait anxiety scores. The abstinent group had slightly higher levels of trait anxiety compared to the other two groups but this difference was not significant ($F(2,75) = 0.48$, $MSe = 95.15$, $p > 0.05$). Analysis of the state anxiety data revealed a main effect of group ($F(2,74) = 6.15$, $MSe = 138.29$, $p < 0.05$). Post hoc analyses showed that abstinent smokers had higher overall levels of state anxiety than active smokers and non-smokers. The main effect of session was not significant ($F(1,74) = 1.28$, $MSe = 34.94$, $p > 0.05$). However, the interaction between session and group was significant ($F(2,74) = 4.31$, $MSe = 34.94$, $p < 0.05$) confirming that abstinence had a significant effect on state anxiety. Least significance difference tests were performed on session one data to determine where the differences lay. Non-smokers had significantly lower state anxiety compared to the abstinent and active smokers. The abstinent and active smokers did not differ.

The analysis of the session two data confirmed the prediction that abstinence would bring about an increase in state anxiety. The abstinent smokers reported significantly higher levels of state anxiety compared to the active smokers and non-smokers. Least significant difference tests revealed that abstinent and active smokers differed in state anxiety. Active smokers and non-smokers state anxiety scores were not significantly different. In summary, the prediction that abstinence would cause an increase in state anxiety was confirmed. The abstinent smokers were the only group to experience an increase in state anxiety from session one to session two. Active smokers did not differ from the non-smokers at session two. In fact the active smokers experienced a reduction in State anxiety from session one to session two. Possibly reflecting a reduction in experimental related anxiety exhibited from session one.

Table 6.4. State and Trait anxiety scores for abstinent smokers, active smokers and non-smokers by session.

Anxiety/session	Group	Mean	SD
Trait anxiety (2)	Abstinent smokers	43.81	11.40
	Active smokers	41.42	9.69
	Non-smokers	41.36	8.53
	All	42.09	9.68
State anxiety (1)	Abstinent smokers	39.78	8.41
	Active smokers	40.04	10.59
	Non-smokers	34.60	7.20
	All	37.63	8.88
State anxiety (2)	Abstinent smokers	44.95	11.33
	Active smokers	38.23	10.13
	Non-smokers	34.54	8.78
	All	38.66	10.77

Self-report measures

The self-report data for desire to smoke, thoughts about smoking, and thoughts about smoking prompted by the Stroop task were entered into an analysis of variance to evaluate the effect of abstinence on these measures. The data are presented in Table 6.5. For the 'want-cigarettes' measure an ANOVA revealed no main effect of session ($F(1,38) = 0.49$, $MSe = 2.31$, $p > 0.05$) but a main effect of smoking status was found, ($F(1,38) = 14.90$, $MSe = 4.86$, $p < 0.001$). Moreover, a significant interaction between smoking status and session was found ($F(1,38) = 25.32$, $MSe = 2.31$, $p < 0.001$), with the only significant difference being between session one and session two measures for the abstinent group ($t(21) = 4.035$, $p < 0.01$).

Therefore, six hours of abstinence created a significant increase in craving for cigarettes. The 'think-cigarettes' measure was analysed in the same fashion. There was a main effect of session ($F(1,40) = 4.08$, $MSe = 3.62$, $p < 0.05$) but the main effect of group was not significant ($F(1,40) = 3.04$, $MSe = 6.27$, $p > 0.05$). However, the interaction between group and session was found to be significant ($F(1,40) = 10.38$, $MSe = 3.62$, $p < 0.05$). Again, only the abstinent smokers had significantly different scores at session two on this measure ($t(22) = 3.318$, $p < 0.01$).

Table 6.5. Abstinent and active smoker's self-reported desire for cigarettes, thoughts about cigarettes, and thoughts about cigarettes prompted by the Stroop task.

Self-report/ (session)	Group	Mean	SD
Want-cigarettes (1)	Abstinent smokers	4.00	1.94
	Active smokers	4.15	1.86
Want-cigarettes (2)	Abstinent smokers	2.04	1.32
	Active smokers	5.63	2.26
Think-cigarettes (1)	Abstinent smokers	4.66	2.53
	Active smokers	4.31	2.23
Think-cigarettes (2)	Abstinent smokers	2.33	1.82
	Active smokers	4.73	2.37
Stroop and thoughts	Abstinent smokers	4.90	2.71
	Active smokers	4.57	2.81

(1 = "very much to 9 = "not at all")

An analysis of the 'Stroop and thoughts' measure revealed no significant differences between the abstinent and active smoking groups. In summary, these results confirm the hypothesis that six hours of abstinence is sufficient time for cravings for cigarettes and an increase in thoughts about cigarettes to occur. The active smokers experienced a slight reduction in craving from session one to session two. Finally, it was found that the engagement in the modified Stroop task had only a moderate impact on the smokers thoughts about smoking with abstinent and active smokers providing responses in the middle range of the 1-9 scale.

Correlation analyses

Multiple Pearson's correlation coefficient analyses were performed for abstinent and active smokers separately. Analyses of active smokers (see Table 6.6) showed that incongruent and congruent smoking word reaction times, and incongruent control word reaction times were significantly positively related to the number of years smoking. This suggests that smokers who have smoked for longer periods of time provided slower reaction times. Given that age and reaction times were significantly related (r (44) = .39, $p < 0.01$) this finding indicates that older participants (who have had longer smoking histories) are generally slower at reaction time tasks. Finally, it was found that the 'Stroop and task' measure which gathered data on participants thoughts about smoking prompted by the Stroop task was significantly related to CO levels at session two. This finding suggests that active smokers were aware that performing the Stroop task made them think about smoking to a moderate level, but that this conscious awareness was a function of levels of CO and had no impact on reaction times.

Analyses of abstinent smokers data (see Table 6.7) showed that smoking word reaction times for incongruent trials were significantly correlated with the SMQ-relaxation sub-scale and the 'Stroop and thoughts' self-report measure. The relationship between the number of years as a smoker and Stroop reaction times (evident in active smokers) was not present in abstinent smokers. The finding that incongruent smoking word reaction times were significantly related to the SMQ-relaxation sub-scale requires further investigation. The SMQ-relaxation sub-scale is made up of two items; 'I like a cigarette best when I am having a quiet rest' and 'I want to smoke most when I am comfortable and relaxed'. The nature of the correlation between the relaxation sub-scale and the Stroop reaction times was such that high scores on the sub-scale were generally associated with slower reaction times for incongruent smoking words. In the light of this finding a post hoc analysis was conducted on the incongruent smoking word reaction times. Initially, a median split procedure was used to divide the abstinent smokers into high and low 'SMQ-relaxation' groups. A mixed ANOVA was then performed involving 'SMQ-relaxation' (high / low) and word type (smoking / control) as factors. The analysis revealed a significant difference between high and low SMQ-relaxation groups ($F(1,20) = 4.95$, $MSe = 20.70$, $p < 0.05$) but the main effect of word was not significant ($F(1,20) = 0.25$, $MSe = 20.70$, $p > 0.05$). However, the word by group interaction was not significant ($F(1,20) = 0.71$, $MSe = 20.70$, $p > 0.05$). Thus, this analysis suggests that low 'SMQ-relaxation smokers' processed all words slower than high 'SMQ-relaxation' smokers but there was no interaction between SMQ group and type of word.

Finally, it was found that incongruent smoking word reaction times were significantly correlated with the measure asking participants to report how much the Stroop task made them think about smoking. This correlation was only significant in the abstinent group. This finding suggests that the performance of the Stroop task in the abstinent smokers was associated with a conscious awareness of smoking concepts, and that this awareness brought about increases in smoking word reaction times. However, the difference between abstinent smokers and active smokers on the 'task and thoughts' measure was not significant, and the strength of the correlation between reaction times and 'task and thoughts' is only moderate. Therefore, it is not possible to draw any firm conclusion concerning the impact of conscious awareness of smoking on Stroop performance.

Following examination of the relationship between the anxiety, smoking demographics, and CO measures in abstinent smokers it was found that the correlation between FTQ and state anxiety at session two was very strong (see Table 6.5). This finding suggests that dependent smokers are more likely to experience higher levels of state anxiety in response to abstinence. Furthermore, it was found that CO measures taken at session two were significantly related to state anxiety at session two. Thus, it is clear that dependent smokers who are abstinent for a period of six hours, experience a drop in blood levels of nicotine (as measured by CO) which may lead to an increase in state anxiety. This analysis confirms the findings of the analysis of differences in state anxiety between abstinent smokers and active smokers. Here it was found that abstinent smokers experienced a significant increase in state anxiety.

When examining the relationship between self-reported craving measures and state anxiety scores it was found that state anxiety was significantly correlated with craving state. The nature of the relationship was such that high levels of state anxiety at session two were accompanied by increased craving for cigarettes and thoughts about cigarettes. Finally, trait anxiety was significantly related to CO levels at session two, and the SMQ-sedative sub-scale was significantly related to trait anxiety. Therefore, these findings support the argument that smokers who are generally anxious experience more anxiety following abstinence and that increases in anxiety are related to drops in carbon monoxide levels.

Table 6.6. Correlations among SMQ sub-scales, FTQ, cigarette craving, state and trait anxiety, and smoking demographics. (Active smokers only N=22).

	VARIABLE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Years smoking	1.00														
2	Cigarettes per day	.54	1.00													
3	FTQ	.23	.68**	1.00												
4	CO(2)	.19	.21	.25	1.00											
5	Want a cigarette (2)	.65*	.15	.06	.44*	1.00										
6	Thinking of a cigarettes (2)	.36	.12	.26	.18	.29	1.00									
7	Task and thoughts	.15	.09	.20	.46*	.17	.80**	1.00								
8	State anxiety (2)	-.04	.18	.14	-.08	.06	.10	-.19	1.00							
9	Trait anxiety	.25	.14	.04	.24	.33	.31	.15	.62**	1.00						
10	SMQ-Relaxation	-.12	.40	-.04	-.20	-.52*	-.08	-.10	.19	-.05	1.00					
11	SMQ-Sedative	-.28	.33	.23	.03	-.13	-.03	.21	-.03	.12	-.02	1.00				
12	Smoking words (incongruent)	.60*	.25	-.06	.08	.33	.14	-.03	.18	.14	-.16	.05	1.00			
13	Smoking words (congruent)	.62*	.06	.01	.03	.22	-.01	-.29	.28	.16	.07	.25	.74**	1.00		
14	Control words (incongruent)	.54	.02	.00	.00	.41	.39	.09	.16	.20	-.34	.15	.84**	.68**	1.00	
15	Control words (congruent)	.67*	.17	-.06	.05	.39	.08	-.10	.07	.16	-.27	.01	.93**	.71**	.82**	1.00

(* = correlations significant at 0.05 level. ** = significant at the 0.01 level).

Table 6.7. Correlations among SMQ sub-scales, FTQ, cigarette craving, state and trait anxiety, and smoking demographics (Abstinent smokers only N=23).

	VARIABLE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Years smoking	1.00														
2	Cigarettes per day	-.38	1.00													
3	FTQ	-.13	.68**	1.00												
4	CO(2)	.30	.12	.37	1.00											
5	Want a cigarette (2)	.22	-.14	-.38	-.06	1.00										
6	Thinking of a cigarettes (2)	-.06	-.19	-.50*	-.25	.55**	1.00									
7	Task and thoughts	-.20	.19	-.14	.06	.17	.12	1.00								
8	State anxiety (2)	-.29	.39	.60**	.53*	-.38*	-.38*	-.09	1.00							
9	Trait anxiety	-.30	.15	.39	.47*	-.40	-.32	-.04	.66**	1.00						
10	SMQ-Relaxation	.31	-.16	-.21	.08	.20	.14	.38	-.18	-.23	1.00					
11	SMQ-Sedative	.04	-.02	.06	.21	-.42	-.42	.04	.27	.59**	-.16	1.00				
12	Smoking words (incongruent)	-.10	-.04	.10	.18	-.39	-.27	-.44*	.04	.38	-.62**	-.27	1.00			
13	Smoking words (congruent)	-.09	.16	.19	.02	-.31	-.09	-.17	-.12	.21	-.49	.10	.75**	1.00		
14	Control words (incongruent)	-.28	.08	.13	.20	-.38	-.20	-.30	.17	.56**	.54**	.32	.86**	.69**	1.00	
15	Control words (congruent)	-.05	.18	.28	.05	-.40	-.17	-.23	.12	.36	-.61**	.04	.79**	.86**	.73**	1.00

(* = correlations significant at 0.05 level. ** = correlations significant at the 0.01 level).

6.4 Discussion

The main aim of this study was to examine the effect of abstinence on the cognitive processing of smoking words. A second aim was to investigate the relationship between word processing, smoking demographics, smoking motivation and state anxiety. Although the overall Stroop effect was observed, confirming the validity of the Stroop modification, no further effects were observed. No differential processing of smoking and control words was evident in abstinent smokers. The analyses of the effects of abstinence on self-report measures found that abstinence produced an increase in state anxiety and increases in cravings for cigarettes. Six hours of abstinence was also found to significantly reduce CO levels. Furthermore, correlation analyses found that in abstinent smokers the 'Stroop and task' measure was related to reaction times for incongruent smoking word Stroop trials. In active smokers reaction times were related to the number of years the participant had been a smoker, and thoughts prompted by the Stroop task were related to session two CO levels.

The main finding that all participants responded slower to incongruent trials than to congruent trials is confirmation that a Stroop effect was created by the Stroop modification employed. This is contrary to the previous study and suggests that the modification employed is a satisfactory Stoop measure. Furthermore, it was found that the main effect of smoking status approached significance. This indicated that active smokers' had slower reaction times for both word types compared to the abstinent and non-smoker groups. This near significant difference may be explained by the finding that active smokers had smoked for significantly more years than the abstinent group. Correlation analyses found that the number of years smoking was significantly related to overall reaction times only in active smokers ($r = .39$). Thus, a likely explanation is that those smokers who had been smokers for longer (and who were therefore older) provided longer reaction times. The three-way interaction involving congruence with word type and smoking status was not significant. Thus, there was no evidence of differential word processing in any of the groups, and the abstinent smokers did not show a predicted cognitive bias for smoking words.

There are several possible explanations as to why the hypothesised bias in abstinent smokers was not observed. Firstly, the period of abstinence may have not have been sufficient to bring about a cognitive bias. However, it was found that six hours of abstinence was sufficient time to bring about significant changes in self-reported desire to smoke and thoughts about cigarettes. Abstinent smokers were therefore clearly experiencing a measurable change in their subjective state following abstinence. Given the findings of Gross et al. (1993) who reported similar changes in abstinent smokers craving self-reports, it would be expected that the abstinent smokers in this study would demonstrate the predicted bias for smoking words. Secondly, the modified Stroop task adopted for this study may have been insensitive to the bias that the abstinent smokers might have been undergoing.

Several aspects of the Stroop modification used may have led to its insensitivity. The task given to the participants was to compare a colour word with the colour ink used to present a stimulus word located in a different location to the colour word, and to respond with the appropriate keyboard response. Thus, colour was embedded in each word stimulus, and congruence judgements were achieved by requiring participants to compare the colour used to display the stimulus word with the colour specified by a colour word (e.g. BLUE). Although this allowed manual responses to each stimulus to be recorded with accuracy, this modification may have resulted in participants being able to adopt a strategy which enabled them to complete the central task of colour matching whilst ignoring the stimulus word.

Williams, Mathews and MacLeod's (1996) review of the emotional Stroop task supports this explanation. Williams et al. (1996) suggest that null findings in the use of emotional or modified Stroop tasks are suggestive of the possibility that in some circumstances, participants are able to use explicit strategies to override interference from salient stimuli in a Stroop based task. This is particularly the case if the response mode is manual and stimulus and colour words are separated in the stimulus array. Furthermore, Fox (1993) has suggested that the conventional Stroop colour-naming paradigm is not a good test of selective attention and is therefore unable to determine whether a bias is selective or not. In a study of attentional bias in anxiety Fox (1993) used a conventional colour naming Stroop task and a 'separated' Stroop task in order to test the hypothesis that information presented in the visual field, but not in the same location as the target stimulus, would cause interference on a central colour naming task. The results broadly confirmed this hypothesis. High trait anxious participants demonstrated colour-naming interference for threat-related words in a conventional Stroop modification, low anxious individuals did not. More importantly, high trait anxious participants were the only group to be distracted by colour-related and threatening stimuli presented outside the location of a colour patch. Thus, this result suggests that high anxiety is characterised by an inability to ignore all distracting information, irrespective of its valence. However, in the context of the present study such findings indicate the possibility that the modification used gave rise to the ability of participants to adopt an explicit strategy to selectively avoid the stimulus word. This may have been possible because the task required participants to monitor a colour word in a location below the critical word stimulus location.

In summary, the form of modified Stroop used in this study may not have allowed for any semantic processing of the stimulus word to occur. Therefore, in the context of the present study the task may have been unable to determine whether smoking abstinence creates a bias for smoking-related words. However, it was found that abstinent smokers' reaction times for incongruent smoking words were correlated with the 'tasks and thoughts' measure, which suggests that the task did make the smokers aware of smoking. This may have brought about a conscious awareness in the abstinent smokers and activation of smoking-related concepts. There was an indication in the data that abstinent smokers had slower reaction times for smoking words if they reported that the Stroop task made them think about smoking. However, this finding will require further investigation before any firm conclusions can be drawn.

It was also found that abstinence brought about a predicted change in self-reported cravings to smoke. Abstinent smokers had a significantly increased desire for cigarettes following six hours of abstinence. Furthermore, the period of abstinence also brought about a significant increase in state anxiety in abstinent smokers. Active smokers actually experienced a reduction in state anxiety from baseline following six hours of active smoking. Thus, this study confirms that the state anxiety scale is sensitive to changes in affect experienced by abstinent smokers. As in the previous study the finding that smokers were more state anxious than non-smokers might reflect the situational or expectancy anxiety of the smokers.

Correlation analyses were performed, involving state and trait anxiety, craving for cigarettes measures, SMQ sub-scales, FTQ, and CO measures. It was found that abstinent smokers' state anxiety was significantly correlated with an increase in craving for cigarettes. Furthermore, state anxiety was significantly related to FTQ scores and post abstinence CO levels. Therefore, it is apparent from the analysis of CO levels (which are related to blood nicotine levels) that increases in anxiety are related to the effects of nicotine deprivation. In conclusion, dependent smokers who experience short periods of abstinence, and a subsequent decrease in plasma nicotine levels, experience a significant increase in state anxiety.

Of particular interest was the finding that the SQM-Relaxation sub-scale was related to incongruent smoking word Stroop reaction times in active smokers only. A post hoc analysis of the incongruent word trials was conducted to further explore this relationship. It was found that low 'relaxation' smokers demonstrated slower reaction times for smoking and neutral words but there was no evidence of differential word processing in this group. This finding lends support to Fox's (1993) modified Stroop effects hypothesis, which suggests that Stroop effects are due to anxiety, but because the task is no being performed in a Stroop like way the effect is emerging as a simple reaction time response.

6.5 Conclusions

Whilst this study confirmed the suitability of the Stroop modification to measure Stroop interference it failed to detect bias effects in abstinent smokers. Therefore, it is still not possible to draw any firm conclusions concerning the effects of abstinence on the processing of smoking-related words. Several explanations were presented for the insensitivity of the Stroop modification but the exact cause of the null findings is difficult to determine. However, it was found that six hours of abstinence was sufficient to bring about a reduction in expired CO and an increase in desire and need for cigarettes. Furthermore, state anxiety increased following six hours of abstinence.

Of particular interest was the finding that incongruent smoking word reaction times were correlated with the measure asking participants to report how much the Stroop task made them think about smoking. This relationship was only present in the abstinent group which suggests that this group's experience of increased anxiety and increased craving for cigarettes heightened their awareness of the smoking-related stimuli used in the Stroop task

Finally, it was found that the SMQ-relaxation sub-scale was negatively correlated with reaction times for incongruent trials. This relationship was only apparent in active smokers, and after further investigation it was found that low 'SMQ-relaxation' smokers demonstrated a non-specific increase in reaction times. Therefore, it seems that those smokers who reported that they smoke primarily when they are relaxed and feeling calm, tended to respond slower to incongruent Stroop trials. There was no evidence of cognitive bias in this group. It therefore remains to be seen whether this pattern of results will emerge in future studies which intend to further investigate the relationship between SMQ-sub-scales and Stroop performance in abstinent and active smokers. The next chapter sets out a study that addresses the specific issues relating to the Stroop modification discussed earlier, and will further explore the hypothesis that abstinent smokers show a cognitive bias for smoking words.

Chapter Seven

Study Five

Short Term Smoking Abstinence Produces a Cognitive Bias for Smoking-Related Words

7.1 Introduction

The aim of the study presented in Chapter Six was to access the effect of smoking abstinence on the cognitive processing of smoking and control word stimuli. The results showed that abstinent smokers did not respond differentially to the smoking stimuli. There are two explanations for these findings. The first is that abstinent smokers do not exhibit a bias to smoking word stimuli. The second is that the modified Stroop modification was insensitive to effects of abstinence. This is because the abstinent smokers may have employed an override strategy that enabled them to ignore the stimuli.

Given that previous research findings have shown a bias in abstinent smokers it is possible to assess the validity of the two explanations through a partial replication of the Gross et al. (1993) study. This is the aim of the study presented in this chapter. Whilst the previous research did not support Gross et al's cognitive bias hypothesis it did reveal some interesting relationships between abstinence and a battery of self-report measures. In particular, it showed that abstinence increased state anxiety, self-reports of cravings for cigarettes and thoughts about cigarettes. Furthermore, the previous study found that abstinent smokers reported that performing the Stroop task made them think about smoking suggesting that abstinence creates a conscious awareness of smoking preoccupation which impacts on smoking word processing. A further aim of the present study is to investigate these factors and provide further evidence about the role of awareness on word processing.

As noted earlier, there is evidence to suggest that single trial modifications of the Stroop protocol are not as sensitive to incongruency effects as traditional card-based measures, and that non-vocal response forms of the task generally result in a weaker effect (Sharma, 1998). Moreover, doubts have been expressed about the validity of standard Stroop modifications (Fox, 1993). It has been argued that standard single trial Stroop protocols measure fundamentally different underlying mechanisms (Fox, 1993; Williams, 1996). For example, a study by Kindt, Bierman and Brosschot (1996) investigated the test-retest reliability and convergent validity of an Emotional spider Stroop and Standard Stroop task in card and single trial formats. Undergraduate participants were allocated to one of four test-re-test conditions: Single-trial-card format (same word order); single-trial-card format (different word order); card format-single-trial format, (same word order) and finally, card-single-trial format, (different word order). Standard Stroop words were incongruent colour words and emotional Stroop words were spider-related and neutral words. The Spider Phobia Questionnaire (Klorman, 1974) was used to assess fear for spiders in the sample, so that differential responses in spider fearful participants to spider-related words could be measured in the emotional Stroop. It was found that for the standard Stroop format the test-retest reliability for the card and single-trial format was low but significant, and for the emotional Stroop effect it was very low and non-significant. The card format of the task yielded the highest test-retest correlation and was also found to be the most difficult of the formats. Thus, the card Stroop task yielded the largest Stroop effect compared to the single trial format. The authors concluded that the two formats measure different underlying mechanisms, and that the use of the Emotional Stroop is only of value if it is combined with psychometric research. Similar evidence comes from Holle, Neely and Heimberg (1997) who studied the effects of blocked versus random presentations of words in an Emotional Stroop task in social phobics. Significant differences in colour-naming were only found when the word stimuli were presented in blocked format.

It has also been demonstrated that clinically anxious subjects show less performance fluctuations on Stroop tasks because they find it hard to ignore threatening information (Williams, 1986). In contrast, non-clinical populations show greater resource fluctuations and more variable Stroop performance (Williams, 1996). Therefore, what the research into this issue suggests is that card-based formats of the Stroop task yield the most consistent data, and are the most demanding of the various formats employed. In the light of this evidence it is reasonable to assume that the null findings of the previous study may in some part be due to the adoption of a randomised single trial Stroop format.

As reviewed in earlier chapters, Gross et al. (1993) demonstrated Stroop interference for smoking-related words in abstinent smokers using a card emotional Stroop. Participants were required to name aloud the colour of ink in a set of words while trying to ignore the meaning of the words presented. The results showed that abstinence produces a preoccupation with smoking-related stimuli which leads to smokers being unable to suppress smoking-related information during the performance of the Stroop task. Furthermore, abstinent smokers had significantly higher cravings to smoke than the active smokers. Therefore, for the purposes of this thesis it is argued that it is necessary to evaluate the effects of abstinence on word processing when using a card emotional Stroop.

The previous study found that abstinent smokers reported that they were consciously aware of smoking concepts whilst performing the Stroop task. Thus, the abstinent smokers were aware of their preoccupation with smoking concepts and this resulted in slower reaction times to smoking words. Therefore, the previous study provided partial evidence that cognitive bias in abstinent smokers is a conscious process. The present study provides a further opportunity to investigate this issue. Analysis will focus on the relationship between self-reports of craving, awareness of smoking prompted by the Stroop task and to the effects of abstinence on anxiety and self-reported cravings.

In summary, the present study will examine addicted smokers processing of smoking-related words using a card-based emotional Stroop. This study will test the hypothesis that abstinence creates a cognitive bias for smoking-related words. It is predicted that abstinent smokers' colour reading latencies for smoking-related words will be slower than latencies for neutral words. As with the previous study it is also predicted that abstinence will create higher levels of state anxiety, and craving for cigarettes compared to active smoking. Finally, it is predicted that abstinent smokers will experience an awareness of smoking concepts prompted by the Stroop task.

7.2 Method

Participants

A total of 78 participants took part in the study. Participants were recruited from the Middlesex University undergraduate participant pool. They received a course credit for participation. There were 40 abstinent smokers, 23 active smokers, and 15 non-smokers. The median age of the smokers was 21, and the median age of the non-smokers was 22. The non-smokers comprised a group who had never smoked cigarettes, other than some instances of experimentation in adolescence.

Design

A mixed factorial design was employed in which abstinent smokers, active smokers and non-smokers were presented with smoking and neutral words. Abstinent smokers were required to abstain from smoking for six hours and active smokers smoked normally for the same period. The main dependent variable was colour-naming latency for each sets of words. For the Stroop task a single presentation order was created for the smoking word set, the same order was used for the control words. Smoking and control words were presented on a white background in two columns separated by 1cm in 32pt New York font. The four colours used were: red, green, blue and black. No two colours were presented consecutively, and each colour appeared in every block of four words.

Materials

As with previous studies smoking and control words were used as stimuli. The words were presented using a Power Macintosh Computer. Superlab V1.2 was used to present each set of words on the computer screen. The software calculated response latencies for each block of words to the nearest 1/60th of a second. Smoking dependence was measured by the FTQ (see Appendix 5.1) and the Spielberger State-Trait Anxiety Inventory was used to measure anxiety. CO testing was conducted using a Bedfont Smokerlyzer. To assess smoking motivation the revised 19-item SMQ was employed (see Appendix 4.7). Self-reported craving for cigarettes, thoughts about cigarettes and thoughts about cigarettes prompted by the Stroop task were measured by Likert-type scales ranging from one; 'very much' to nine; 'not at all' (see Appendix 6.1 for craving measures).

Procedure

Each participant was tested individually. Participants arrived for the first session between 0900 and 1100 a.m. and were met by the experimenter. The experiment was explained and consent for participation was obtained. Participants completed the state and trait anxiety forms Y-1 and Y-2 and were then randomly allocated to either abstinent or active smoking conditions. If allocated to the abstinent condition they were asked to refrain from smoking for six hours before returning for the second session. Active smokers were instructed to smoke normally until the second session and to smoke one hour prior to their second session. At session two each participant was asked if he or she smoked and to provide a breath sample for CO analysis. Participants then completed the State anxiety form Y-1. Following this the Stroop task was administered.

In each group participants were allocated one of two word orders. They either performed the task for the smoking word set first followed by the neutral words or the reverse. Following this, participants completed the ratings of desire to smoke, craving for cigarettes, and thoughts about smoking prompted by the Stroop task. Non-smokers attended a single session at which they first completed the State anxiety and Trait anxiety forms and then performed the Stroop task in the same fashion as the other groups, with the same conditions applying. Following the completion of all tasks participants were debriefed and thanked for their participation. Each participant received a course credit for their participation.

7.3 Results

Participant demographics

Demographic data for abstinent and active smokers are presented in Table 7.1.

Table 7.1. Smoking demographics for abstinent smokers and active smokers.

Group	Variable	Mean	Min	Max	SD
Abstinent Smokers	Cigarettes smoked per day	20.80	15.0	30.0	6.42
	Years smoking	9.47	2.0	22.0	5.17
	Fagerström Tolerance Score	5.16	2.0	8.0	1.05
Active smokers	Cigarettes smoked per day	19.34	10.0	40.0	5.89
	Years smoking	8.26	3.0	20.0	3.80
	Fagerström Tolerance Score	5.03	2.0	9.0	1.18

Abstinent and active smokers did not differ in the number of years they had been smoking (t (61) = 0.98 p > 0.05) or the number of cigarettes smoked per day (t (61) = 0.89 p > 0.05). Furthermore, the two groups did not differ on their FTQ scores (t (61 = 0.46 p > 0.05).

Carbon Monoxide measures

Carbon monoxide measures were analysed to verify abstinence. At session two the abstinent smokers mean CO reading was 5.0 ppm (SD=3.08, min = 1, max = 12), compared to the active smokers whose average CO reading was 10.42 ppm (SD=5.15, min = 4, max = 18.00), this difference was significant (t (61) = -2.88, p < 0.05) verifying that abstainers had not smoked and active smokers had continued to smoke. No smokers in the abstinent group reported smoking during the six hour experimental period. As no pre-abstinence CO data were obtained it was not possible to apply the 50% reduction criteria to CO readings as in the previous study. The significant difference found between the abstinent and active smokers was considered sufficient to confirm adherence to the experimental requirement to not smoke for 6 hours.

Stroop analysis

As with previous studies the smoking-related and neutral word colour naming times were examined for univariate normality. Reaction times were converted into Z scores and it was found that reaction times for smoking and neutral words were normally distributed with no participants providing responses beyond a Z score criterion (Z >3.10, p< .001).

For the main analysis a mixed three (abstinent / active /non-smokers) by two (smoking word / control word) ANOVA was performed on the colour naming latencies. The colour-naming data are presented in Table 7.2 and depicted in Figure 7.1.

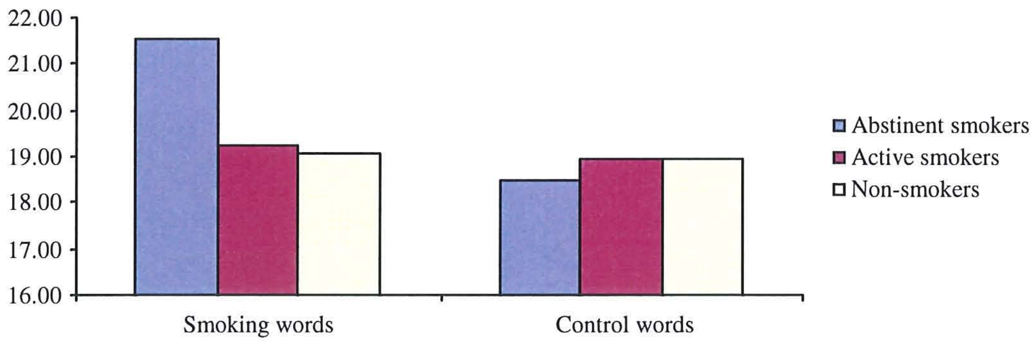
Table 7.2. Colour naming reaction times for group by word set.

Word Type	Abstinent Smokers		Active smokers		Non Smokers		All	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Smoking words	21.56	6.42	19.25	4.70	19.07	3.36	19.96	5.54
Control	18.47	4.94	18.95	4.92	18.94	2.84	18.79	4.56
All	20.01	5.24	19.10	4.13	19.01	2.77	19.01	4.52

The analysis found no main effect for smoking status (F (2,75) = 0.42, *MSe* = 41.53, p > 0.05). However, the main effect for type of word was significant (F (1,75) = 4.65, *MSe* = 9.86, p < 0.05) indicating that colour naming for smoking words was slower than for neutral words for all groups. Furthermore, there was a significant interaction between smoking status and word type (F (2,75) = 4.05, *MSe* = 9.86, p < 0.05).

Post hoc analyses revealed that abstinent smokers had significantly slower colour naming latencies for the smoking words compared to neutral words (F (1,75) = 17.97, p < 0.001). Smoking and neutral word colour naming for the active smokers group did not differ (F (1,75) = 0.07, p > 0.05) and the latencies for non-smokers did not differ (F (1,75) = 0.03, p > 0.05).

Figure 7.1. Smoking and control word reaction times for abstinent, active smokers and non-smokers.



State and Trait anxiety scores

The trait anxiety data for the three groups are presented in Table 7.3. Although non-smokers had higher trait anxiety scores than the other groups, analysis revealed that there were no significant differences between the groups (F (2,77) = 0.95, *MSe* = 112.92, p > 0.05).

Table 7.3. Trait anxiety scores by group.

Group	Mean	SD
Abstinent smokers	38.10	10.95
Active smokers	39.00	10.05
Non-smokers	42.53	10.57

Session one data (see Table 7.4) were analysed in order to detect possible differences between abstinent smokers, active smokers and non-smokers that were found in Chapters Five and Six. It was found that there were no significant differences between the three groups ($F (2,77) = 2.04$, $MSe = 103.42$, $p > 0.05$). Following this a mixed two-way ANOVA was conducted on state anxiety scores. The analysis revealed no main effect of smoking status ($F (1,61) = 0.90$, $MSe = 146.66$, $p > 0.05$), however there was a main effect of session ($F (1,61) = 23.75$, $MSe = 77.75$, $p < 0.05$) indicating that anxiety levels increased from session one to two. This effect was partly explained by a significant interaction between smoking status and session ($F (1,61) = 11.98$, $MSe = 77.75$, $p < 0.05$) which is depicted in Figure 7.2.

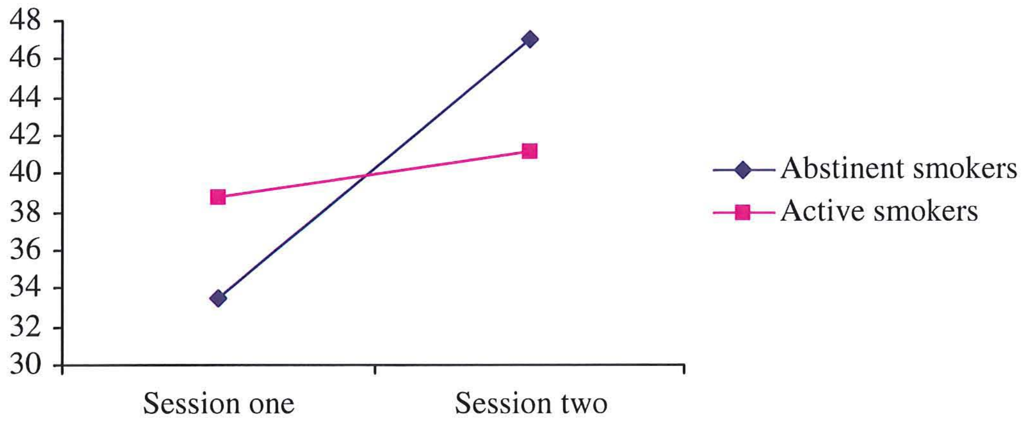
Further analyses showed that whereas abstinent smokers experienced a significant increase in state anxiety from session one to session two ($t (39) = -6.11$, $p < 0.01$) active smokers did not ($t (22) = -1.23$, $p > 0.01$).

Table 7.4. State anxiety scores for abstinent smokers and active smokers by session.

	Session One		Session two		All	
Group	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Abstinent smokers	33.45	10.24	47.05	12.40	40.25	8.94
Active smokers	38.82	8.62	41.13	9.44	39.97	7.84
All	35.41	9.96	44.88	11.68	39.28	9.35

Furthermore, the differences between abstinent and active smokers at session two was found to be significant ($t (61) = 1.98$, $p = 0.05$). Therefore only the abstinent smokers experienced a significant increase in anxiety.

Figure 7.2. State anxiety scores for abstinent and active smokers by session.



The self-report data for desire to smoke, thoughts about cigarettes, and thoughts about smoking prompted by the Stroop task are presented in Table 7.5. Analyses showed that there was a significant difference between abstinent smokers and active smokers in ratings for wanting a cigarette ($t(61) = -5.00$, $p < 0.001$). It was also found that thoughts about cigarettes were higher in the abstinent smokers than in the active smokers ($t(61) = -3.78$, $p < 0.001$). Furthermore, the Stroop task prompted a significant difference between the abstinent smokers and active smokers in thoughts about smoking ($t(61) = -2.79$, $p < 0.05$). This suggested that the Stroop task had a significant influence on conscious awareness of smoking concepts.

Table 7.5. Subjective reports of craving and thoughts about cigarettes. (Based on a Likert type scale; one = very much to nine = not at all).

Group/self report	**Session two**	
Abstinent smokers (n=40	**Mean**	**SD**
Want-cigarettes	2.54	1.72
Think-cigarettes	2.80	1.70
Task and thoughts	2.80	1.67
Active smokers (n=23)		
Want-cigarettes	4.79	1.69
Think-cigarettes	4.46	1.62
Task and thoughts	4.05	1.76

Correlation analyses

Multiple Pearson's correlation coefficients were carried out on reaction time data, smoking motivation, self-reports and smoking demographics for abstinent and active smokers separately. For the active smokers (see Table 7.6) it was found that smoking and neutral word colour naming latencies were significantly related to the 'Stroop and thoughts' measure. Thus, active smokers who reported that they were thinking about smoking following completion of the Stroop task provided slower colour naming latencies for smoking and neutral words. It was also found that the 'Stroop and thoughts' measure was related to the number of cigarettes smoked per day. However, there was no evidence in the data of differential effects of smoking awareness on word processing. It was also found that smoking word colour naming latencies were moderately related to the number of cigarettes smoked per day. Furthermore, the SMQ-sedative sub-scale was related to smoking word colour-naming latencies, suggesting that those smokers who reported smoking to reduce negative affect were slower at colour naming smoking words. This analysis indicates that smoking motivation was a significant factor in the active smokers processing of smoking words. This indicates that smoking words distracted 'affect modulation' smokers when they were performing the Stroop task.

For the remaining variables in the analysis it was found that the SMQ-sedative and SMQ-relaxation sub-scales were related to the number of years active smokers had been smoking. Furthermore, a significant correlation was found between the SMQ-relaxation sub-scale and the thinking about cigarettes self-report measure. The overall impression gained from these findings is that the active smokers in this study represented a group of 'affect management' smokers. This interpretation is also supported by the finding that trait anxiety was significantly related to the number of cigarettes smoked per day Finally, it was found that the 'want-cigarettes' and the 'think-cigarettes' measures were correlated with CO levels, suggesting that higher levels of CO were associated with decreased levels of craving.

The data for abstinent smokers (see Table 7.7) were analysed and it was found that no variables were significantly related to colour naming latencies for smoking or control words. However, it was found that the 'Stroop and thoughts' measure was significantly related to trait anxiety and the number of years the participants had been smoking. This result suggests that higher levels of trait anxiety are associated with increased awareness of smoking during performance of the Stroop task. Furthermore, it was found that state anxiety was significantly correlated to the number of cigarettes smoked per day, CO levels, and ratings of wanting a cigarette. This result indicates that smokers who smoke a large number of cigarettes per day respond to abstinence with increases in state anxiety and increases in cravings for cigarettes. Finally, it was found that daily cigarette intake was related to the 'want-cigarettes' and 'think-cigarettes' measures. Thus, these findings provide corroborating evidence for the conclusion that abstinence effects are more profound for smokers who are trait anxious and smoke a large number of cigarettes. Furthermore, the findings suggest that those abstinent smokers who become aware of their preoccupation with smoking concepts when performing Stroop tasks have smoked for long periods of time and have higher levels of trait anxiety.

Table 7.6. Correlations among SMQ sub-scales, cigarette craving, state and trait anxiety, and smoking demographics. (Active smokers N=23).

	VARIABLE	1	2	3	4	5	6	7	8	9	10	11	12
1	Years smoking	1.00											
2	Cigarettes per day	.47*	1.00										
3	CO(2)	-.13	.23	1.00									
4	Want a cigarette (2)	.12	.07	-.49**	1.00								
5	Thinking of a cigarettes (2)	.27	.03	-.50**	.84**	1.00							
6	Task and thoughts	.27	.52*	-.34	.51**	.43*	1.00						
7	State anxiety (2)	-.13	.08	.02	-.31	-.22	-.05	1.00					
8	Trait anxiety	.17	.40*	-.25	.29	.18	.28	.20	1.00				
9	SMQ-Relaxation	.49**	.11	-.10	.35	.36*	-.16	-.44*	.01	1.00			
10	SMQ-Sedative	.56**	.55**	.20	-.16	-.18	.00	-.23	.15	.49**	1.00		
11	Smoking words	.29	.43*	-.21	.32	.33	.52**	-.23	.00	.16	.49**	1.00	
12	Neutral words	-.05	.07	-.22	.15	.13	.57**	-.02	-.22	-.21	-.20	.47*	1.00

(* = correlation significant at 0.05 level. ** = significant at the 0.01 level).

Table 7.7. Correlations among SMQ sub-scales, cigarette craving, state and trait anxiety, and smoking demographics. (Abstinent smokers N=40).

	VARIABLE	1	2	3	4	5	6	7	8	9	10	11	12
1	Years smoking	1.00											
2	Cigarettes per day	.08	1.00										
3	CO(2)	.10	.10	1.00									
4	Want a cigarette (2)	.00	-.34*	.00	1.00								
5	Thinking of a cigarettes (2)	-.13	-.28*	.00	.72**	1.00							
6	Task and thoughts	-.37*	-.25	-.25	.04	.34*	1.00						
7	State anxiety (2)	.07	.26*	.38*	-.37*	-.24	-.01	1.00					
8	Trait anxiety	-.14	-.01	-.02	.13	.21	.32*	.03	1.00				
9	SMQ-Relaxation	.07	.04	.03	-.07	-.18	.23	.03	.08	1.00			
10	SMQ-Sedative	-.42**	.09	-.15	.00	-.08	.14	-.03	-.02	.13	1.00		
11	Smoking words	-.09	.08	.15	.06	.07	-.16	.20	-.12	.14	-.05	1.00	
12	Control words	.00	.03	-.13	-.01	-.02	-.16	.04	.02	.02	-.07	.70**	1.00

(* = correlation significant at 0.05 level. ** = significant at the 0.01 level).

7.4 Discussion

The main aim of this study was to test the hypothesis that abstinence produces Stroop interference for smoking-related words in a card-based emotional Stroop. This study also intended to gather further evidence of the effects of abstinence on anxiety and self-reported cravings for cigarettes. It was predicted that abstinence would increase state anxiety and increase cravings for cigarettes and thoughts about cigarettes. Furthermore, it was hypothesised that the Stroop task would make abstinent smokers aware of smoking concepts.

The main analysis found the predicted effect of abstinence on smoking word processing. Abstinent smokers demonstrated slower colour naming times for smoking words compared to neutral words, whereas active smokers and non-smokers showed no differential colour naming for the two word types. This result corroborates the findings of Gross et al. (1993) and can be interpreted a preoccupation with smoking-related information in abstinent smokers. That is, abstinent smokers find it difficult to ignore the meaning of smoking-related words using a card-based emotional Stroop. By contrast active smokers and non-smokers did not demonstrate a preoccupation and no differential processing of smoking and control words was found in these groups.

Stroop interference for smoking words in abstinent smokers is consistent with several contending arguments (Gross et al., 1993). The effects may be due to a shift in cognitive focus resulting in selective processing. Alternatively, interference may be a consequence of an increase in cognitive activation. Finally, it may be the result of sensitivity to drug-related information. Given the difficulty of interpreting the locus of Stroop interference effects (Stirling, 1979; Ruiter and Brosschot, 1994; Williams, 1996) a definitive explanation of the aetiology of Stroop interference requires further research. However, it is clear from the findings that abstinent smokers were thinking more about cigarettes, were experiencing increases in state anxiety, and reported that the Stroop task made them think about smoking. These additional findings are parsimonious with a cognitive bias hypothesis.

Alternatively, given the evidence that nicotine administration has been shown to increase vigilance (Edwards, Wesnes, Warburton & Gale, 1985; Wesnes & Warburton 1983; Wesnes & Parrott, 1992) and improve reaction times on a Standard Stroop task (Provost & Woodward, 1991) it could be argued that nicotine deprivation would bring about a decrement in vigilance and reaction times on a Stroop task. However, the findings from Chapter Six suggest that abstinent smokers have faster reaction times than active smokers. Furthermore, no main effect of smoking status was found in the present study.

The finding that abstinent smokers show cognitive bias for smoking words is consistent with studies examining processing biases in anorexics (Channon et al., 1988), food deprived participants (Channon & Hayward, 1990), and alcohol users (Bauer, 1998). The data are also consistent with Tiffany's cognitive model of drug urges and drug use behaviour (Tiffany, 1990,1995b). Briefly, Tiffany's theory posits that when a drug user is confronted with a situation in which the drug they seek is not available or they are prevented from using it (e.g. forced abstinence) drug use action schema are impeded which leads to the experience of urges and cravings. Furthermore, the theory predicts that the activation of non-automatic drug use processes manifest themselves in verbal reports as a desire to smoke and an increased negative affect. Therefore, the finding that abstinent smokers reported higher cravings and thoughts about cigarettes suggests that they were experiencing the activation of non-automatic drug-related processes, which were also accompanied by increases in state anxiety and cognitive bias for smoking words.

The Tiffany account is further supported by the finding that abstinent smokers reported that the Stroop task made them think about smoking. In contrast, active smokers did not find the Stroop task prompted thoughts about smoking. Thus, abstinent smokers were aware that they were preoccupied with smoking and the Stroop task prompted such thoughts. However, correlation analysis did not reveal a significant association between reaction times and the 'task and thoughts' in abstinent smokers. A moderate but significant correlation was found in the active smokers. Active smokers provided slower colour naming latencies if they reported that they were not thinking about smoking. However, the correlation between the 'Stroop and thoughts' was significant for smoking and neutral words, which suggests that there was no evidence of differential effects of awareness on word colour-naming. The conclusion that can be drawn from these findings is that abstinent smokers experience a conscious awareness of smoking. Furthermore, the correlation analyses indicate that smoking motivation and smoking demographics are significant predictors of active smokers' reactions to smoking words. These findings suggest important individual differences in the extent to which smokers respond to smoking-related reaction time tasks.

In contrast to the findings of the present study Gross et al. (1993) found that abstinent and active smokers did not differ in their reports of thoughts prompted by the Stroop task. However, this conclusion may be a result of sampling selection. As noted, the Gross et al.'s. (1993) sample were undergoing treatment for drug and alcohol-related problems, and several of the words used by Gross et al. (1993) are related to drug or alcohol use (smell, odor, flavor taste, habit, addiction, death). Therefore, it is quite possible that the participants' thoughts during participation of the Stroop task (and indeed the whole study) were focused on drug and alcohol use as well. Thus, it is reasonable to argue that the measure concerning thoughts about smoking was not salient. The findings of the present study are more reliable because they provide data from a representative sample of 'normal' smokers who were not undergoing treatment for alcohol and drug abuse.

In summary, the evidence from this study suggests that abstinent smokers become aware of their preoccupation with smoking concepts during the performance of a smoking-related Stroop task. Therefore, when these results are combined with the findings of the previous study it is possible to conclude with greater certainty that bias in abstinent smokers is a product of controlled and conscious strategic processing. Whether cognitive bias in abstinent smokers is a product of a combination of automatic and strategic processing, or one type of processing alone is an issue that is beyond the scope of the present thesis. However, the data gathered so far point to this issue as being fundamental to the development of an understanding of cognitive processes in smoking behaviour.

Consistent with the findings from Chapter Six, the present study found that abstinence increases state anxiety and cravings for cigarettes. It was also found that abstinent smokers reported significantly higher ratings of state anxiety, desires to smoke and thoughts about cigarettes. Active smokers did not experience significant changes in subjective measures of anxiety or cigarettes cravings. Therefore this study provides further evidence that investigations of bias in drug use behaviour should account for both abstinence on craving state and how abstinence impacts on participants' affective state. What this study and the previous studies have clearly shown is that a multi-item measure of anxiety such as the Spielberger STAI is sensitive to changes in affect that occur following short periods of abstinence.

Finally, multiple correlation analyses revealed interesting relationships in abstinent and active smokers. In active smokers it was found that the 'task and thoughts' measure was significantly correlated with smoking and control word reaction times, indicating that those active smokers who reported that the Stroop task made them think about smoking gave the slower reaction times. There was no differential word processing evident in these smokers. This finding suggests that some of the active smokers were experiencing a preoccupation with smoking concepts prompted by their participation in the Stroop task. Furthermore, it was also found that the SMQ-sedative sub-scale was related to smoking word reaction times, suggesting that those smokers who smoked to reduce negative affect were more distracted by the smoking words. There was also evidence that the active smokers were generally a group of 'affect modulation' smokers. The SMQ-relaxation and SMQ-sedative sub-scales were significantly related to thoughts about cigarettes, the number of years smoking and state anxiety.

While the analysis of the abstinence data revealed no significant relationships involving Stroop reaction times the 'task and thoughts' measure was related to state anxiety and the number of years smoking. Furthermore, it was found that craving was significantly related to state anxiety and daily cigarette consumption. In summary, the data suggest that individual differences concerned with affect management smoking and daily cigarette intake are important aspects of smoking word processing, and that abstinence does not exclusively produce preoccupation with smoking-related concepts. Nor are responses to smoking-related words solely determined by a single factor.

7.5 Conclusions

This study supported the hypothesis that abstinence produces a content specific shift in attention towards smoking-related words in a card-based Stroop task. The results suggest that smoking-related stimuli are more difficult to ignore and thoughts about smoking more difficult to suppress following six hours of abstinence. Thoughts about smoking prompted by the Stroop task were also found to differ between abstinent and active smokers. Furthermore, state anxiety increased following six hours of abstinence and abstinent smokers reported increased cravings and thoughts about cigarettes. In conclusion, the evidence from the present study supports the argument that abstinent smokers experience a conscious awareness of smoking preoccupation following six hours of abstinence and that smoking-related information distracts attention.

The findings from the thesis show that abstinence produces definite changes in smokers' subjective state. They feel more anxious, and crave and think about cigarettes more. This change in the subjective state of abstinent smoker seems to be a direct result of the reduction in systemic nicotine. CO levels have been found to be consistently related to self-reported desire to smoke and thoughts about cigarettes. The Spielberger State Anxiety Inventory has also been consistently associated with the abstinence effects, self-reported desire to smoke and thoughts about cigarettes.

The studies presented in this thesis have investigated cognitive biases in smokers. This study showed that the information processing of smoking-related words is altered by abstinence. However, the Stroop task does not reveal the precise nature of a processing bias. In order to do this it is necessary to employ a function specific processing task. Given the link between selective attention and Stroop interference hinted at in the discussion the next study will assess attentional bias in abstinent, active and non-smokers.

Chapter Eight

Study Six

Visual Attention to Smoking-Related Words in Abstinent Smokers, Active Smokers and Non-Smokers

8.1 Introduction

The previous study found abstinence related biases for smoking-related words and extended the understanding of the effects of abstinence on smoking-related word processing in smokers. The findings confirmed that the Stroop protocol is informative in the analysis of smokers' reactions to smoking abstinence and their processing of smoking-related stimuli. The aim of the present study is to extend our understanding of information processing biases in abstinent smokers through the use of a measure of attentional bias. Previous research has shown that the Dot Probe task provides a direct measure of this form of bias. The Dot Probe task provides a direct measure of visual shift to the processing of smoking-related stimuli.

Although some researchers have claimed that the Stroop interference effects are due to attentional bias in abstinent smokers (Gross et al., 1993) there is considerable debate about the nature of the information processing bias (Fox, 1993; MacLeod et al., 1986; MacLeod, 1991; Mogg & Bradley, 1998). These researchers argue that interpretations of emotional Stroop interference are ambiguous. The reasons given for this ambiguity are based upon the dual presence of the critical and distracting stimuli. This point was highlighted by Fox (1993) who claimed that the demonstration of selective attention required the separate presentations of the distracting and target stimuli. To do this it is necessary to employ an alternative protocol. The most well known of these is the Dot Probe task.

This conclusion is further supported in a recent study by Mogg, Bradley, Dixon, Fisher, Twelftree and McWilliams (2000). In this study attentional bias for threat-related words was studied in non-clinically anxious participants using a modified Stroop colour-naming task and a Dot Probe task. The dual task approach was used to address discrepant findings in the anxiety literature concerning the nature of attentional bias in anxiety. The study tested the hypothesis that trait anxiety is associated with increased vigilance for threat words and that the bias should result in slower reaction times for threat words in a Stroop task and faster reactions to probes replacing threat words in the Dot Probe task. The results from the Stroop task revealed that a high anxiety group showed increased interference for threat words. For the Dot Probe task it was shown that there was no bias for physical threat words and there was general tendency for all participants to show avoidance for social threat words. Furthermore, no relationships were found between the Stroop and Dot Probe tasks suggesting that the two measures relate to different underlying mechanisms (Mogg et al., 2000). The authors conclude that the Dot Probe task indexes biases in visual orienting that require threat and neutral stimuli to be spatially separated in the visual field. In contrast the Stroop task is more cognitively engaging because it requires the participant to process a stimulus colour while trying to ignore its colour. In the light of such findings it is argued that the use of a dual protocol approach may further an understanding of the cognitive processes underlying smoking abstinence.

The Dot Probe task was reviewed as a potential measure of smokers cognitive processing in Chapter Three. In brief, the Dot Probe was developed by MacLeod et al. (1986) to measure attentional bias in clinically anxious participants. The results showed that clinically anxious participants had faster reaction times for probes appearing in the location of threat words. MacLeod et al. (1986) concluded that anxiety produces overactive danger schemata resulting in hypervigilance to threat. Since this initial study the Dot Probe has been used to assess attentional processing in a range of disorders (MacLeod, 1988; Broadbent & Broadbent, 1988; Mogg, 1994; Mogg, 1995; Broschott, 1999). It has also been used to assess the attentional processing of circumstance specific stimuli (Kroeze, 2000). For example, Mogg, Bradley, Hyare and Lee (1998) found that food abstinent participants showed an attentional bias to food-related stimuli. To date there have been no published studies of attentional bias in abstinent smokers.

The findings from both the previous study and the Gross et al. (1993) study suggest that smoking abstinence results in information processing biases that favour the processing of smoking-related information. The current study aims to clarify the nature of this bias through the use of a protocol that measures visual attentional shift. In addition to the attentional bias measure the following study will continue to study the attentive and subsidiary aspects of smoking emerging from previous studies. Of particular interest is awareness of smoking-related stimuli in the experiment. Finally, as in previous studies it is predicted that abstinent smokers will be more state anxious following abstinence and that they will report increases in cravings and thoughts about cigarettes. Other analyses will be restricted to an examination of the relationship between anxiety, smoking motivation, self-reported cravings and Dot Probe performance.

8.1 Method

Participants

There were 84 participants in the study, of which 32 were abstinent smokers, 24 were active smokers, and 28 were non-smokers. Participants were recruited from Middlesex University's undergraduate psychology participant pool. They received a course credit for participation. The median age of the smokers was 22 and the median age of the non-smokers was 21. Demographic data for smokers are presented in table 8.1 below.

Table 8.1. Smoking demographics for abstinent smokers and active smokers.

Group	Variable	Mean	Min	Max	SD
Abstinent Smokers	Cigarettes smoked per day	19.12	8.00	30.00	5.19
	Years smoking	7.06	2.50	19.00	3.77
	Fagerström Tolerance Score	5.19	2.00	8.00	1.17
Active smokers	Cigarettes smoked per day	21.08	10.00	50.00	8.17
	Years smoking	8.08	3.00	20.00	3.67
	Fagerström Tolerance Score	5.06	2.00	9.00	1.16

The abstinent and active smokers did not significantly differ in the number of years they had been smoking ($t(54) = -1.01$, $p > 0.05$). The number of cigarettes smoked per day by the abstinent and active smoking groups also did not differ significantly ($t(54) = -1.09$, $p > 0.05$). Finally, abstinent and active smokers did not differ on FTQ scores ($t(54) = 0.42$, $p > 0.05$). The non-smokers comprised a group who had never smoked cigarettes, beyond experimentation in adolescence.

Materials

As in previous studies smoking and control words were used as stimuli. CO testing was conducted using a Bedfont Smokerlyzer. Smoking dependence was measured by the FTQ (see Appendix 5.1) and the Spielberger State-Trait Anxiety Inventory was used to measure anxiety. The revised 19-item SMQ was employed to assess smoking motivation (see Appendix 4.7). Self-reported craving for cigarettes, thoughts about cigarettes and thoughts about cigarettes prompted by the Dot Probe task were measured using nine point Likert-type scales (see Appendix 6.1).

Design

A three way mixed factorial design was employed. Smoking status consisted of three levels; six hours abstinence, active smoking and non-smoking. Probe position had two levels; top and bottom, and word position had two levels; top and bottom. The dependent variable was reaction time responses to probes. The specific details of the Dot Probe design are presented below.

Dot Probe Design

A desktop computer (using MEL V1.2 software) was used to present trials and record responses to stimuli to within an accuracy of one millisecond. Each smoking and control word comprised 40 critical word pairs. Another 120 matched control word pairs were created to act as filler material. The software presented the word pairs for a duration of 500-ms, with the word pairs separated on the vertical axis of the VDU by a distance of 3cm. Dot probes occurred on 40 of the 120 trials and could replace either of the two displayed words. On trials without probes the next pair of words followed in one second; on probed trials the dot remained on the screen until the participant responded. It was these trials that comprised the data of interest. The smoking word in each critical pair could appear with equal probability in either of the two spatial locations. The probe then followed in the same location as a smoking word, or in the location of the control word with equal probability. Thus, two factors independently varied on each trial: the position of the smoking word and the position of the probe. This produced four possible conditions. Five of the critical trials appeared in each of the conditions.

(1)Smoking word top, control word bottom, probe top
(2)Smoking word top, control word bottom, probe bottom
(3)Smoking word bottom, control word top, probe top
(4)Smoking word bottom, control word top, probe bottom

Procedure

Each participant was tested individually. Participants arrived for the first session between 0900 and 1100 and were met by the experimenter. The experiment was explained and consent obtained. Each smoking participant was randomly allocated to an abstinent or active group. If allocated to the abstinent group they were asked to refrain from smoking for six hours before returning for the second session. Active smokers were instructed to smoke normally for six hours, and to smoke one hour prior to their second session. At session two each participant was asked if he or she smoked and to provide a breath sample for CO analysis. State anxiety and trait anxiety scores were obtained, and the Dot Probe task was administered in a sound attenuated room. The participants received the following instructions on the VDU screen.

> *In this experiment you are going to see words presented on the screen in pairs. One word will appear just above the centre of the screen, and one just below. Please read the top word of each pair aloud as soon as it appears. Sometimes when the two words disappear a small dot will remain either in the area where the top word appeared or in the area where the bottom word appeared. When you see the dot, press the 'd' key as quickly as possible. Are there any questions?*

Following clarification of the instructions the participants completed a set of 15 practice trials before the main experimental trials. At the end of the study participants completed the FTQ, SMQ, self-reported cravings to smoke, and awareness of smoking concepts measure. Non-smoking participants were tested in a single p.m. session. They completed the state and trait anxiety measures and then performed the Dot Probe task. Following completion of all tasks participants were debriefed and thanked for their participation.

8.2 Results

Carbon monoxide readings

CO levels were taken at session two to verify smoking status. It was found that abstinent smokers had significantly lower levels of CO compared to active smokers ($t_{(54)} = -7.45$, $p < 0.05$) verifying the abstinence manipulation. The abstinent smokers mean CO was 5.43 (SD=2.39, min =3, max =12), active smokers mean CO was 14.20 (SD=6.06, min = 4, max = 30). As in chapter seven no pre-abstinence CO data were obtained so the 50% reduction rule was not applied, instead a significant difference in

CO levels between abstinent and active smokers was considered sufficient to verify adherence to the requirement not to smoke during the six hour experimental period. No participants reported smoking during the abstinence period.

Dot Probe analysis

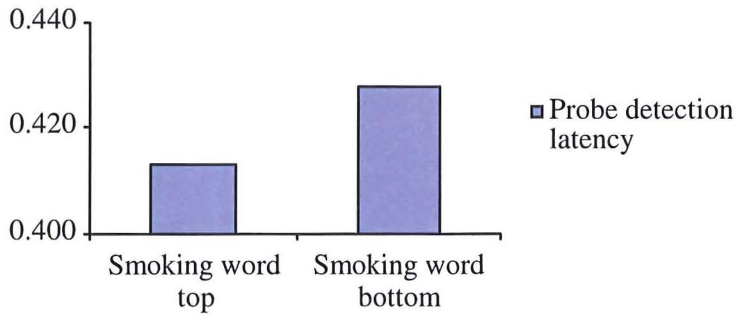
Prior to analysis the reaction time data were screened for outliers and univariate normality. One non-smoking participant was removed because their reaction times were outside the criterion of $Z > 3.10$, $p < .001$. This resulted in a final data set of 32 abstinent smokers, 24 active smokers and 27 non-smokers. The mean reaction times are presented in Table 8.2.

Table 8.2. Probe detection latencies by word position and by group.

Group by area of probe	Smoking word in upper area		Smoking word in lower area		All	
	Mean	SD	Mean	SD	Mean	SD
Abstinent smokers						
Probe upper area	0.400	0.82	0.419	0.110	0.410	0.90
Probe lower area	0.430	0.92	0.441	0.86	0.435	0.83
Active smokers						
Probe upper area	0.374	0.85	0.370	0.90	0.372	0.83
Probe lower area	0.391	0.87	0.382	0.100	0.387	0.89
Non-smokers						
Probe upper area	0.416	0.69	0.473	0.120	0.443	0.83
Probe lower area	0.469	0.106	0.470	0.85	0.469	0.86

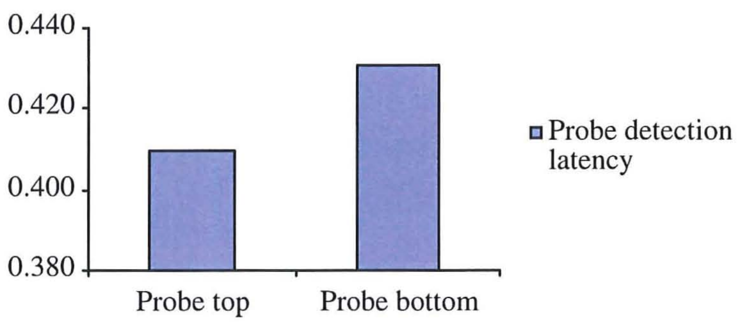
A three (abstinent / active / non-smoke) by two (smoking word position; top / bottom) by two (probe position; top / bottom) ANOVA revealed a significant main effect of word position ($F(1,81) = 4.70$, $MSe = 2.86$, $p < 0.05$). Figure 8.1 shows that words presented at the bottom location had slower probe detection latencies than words presented in the top location.

Figure .8.1. Probe detection latencies for word position main effect.



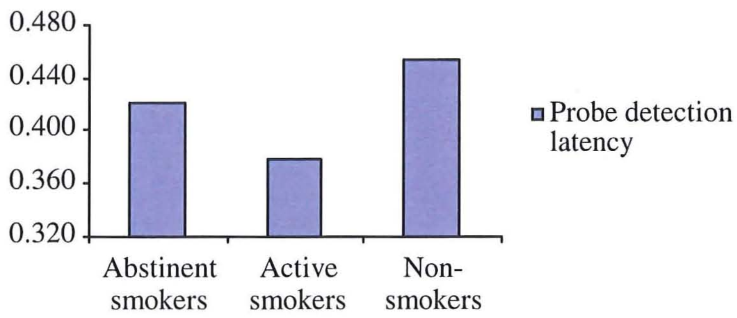
This finding is a product of the requirement to read out loud the word in the top location. There was also a significant effect for probe position ($F(1,81) = 15.68$, $MSe = 2.28$, $p < 0.01$). Figure 8.2 shows that probes presented in the top location were responded to faster than those in the bottom location.

Figure 8.2. Probe detection latencies for probe position main effect.



There was also a significant main effect of group ($F(2,81) = 5.72$, $MSe = 2.75$, $p < 0.05$). Figure 8.3 shows that non-smokers had the slowest reaction times, followed by abstinent smokers and then active smokers. Post hoc Tukey's LSD tests showed a significant difference between the active smokers and non-smokers only.

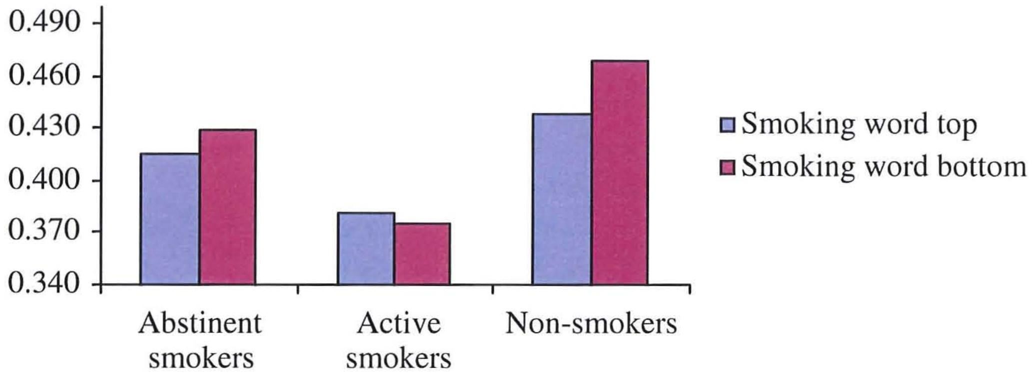
Figure 8.3. Probe detection latencies for smoking status main effect.



Two-way interaction effects for the three factors showed no interaction between probe position and word position (F (1,81) = 3.19, MSe = 2.83, $p > 0.05$). However, there was a significant interaction between smoking status and word position (F (2,81) = 3.54, *MSe* = 2.86, $p < 0.05$). Figure 8.4 depicts the probe detection latencies for the smoking status by word position interaction. Post hoc analyses using Tukey's LSD tests revealed no significant differences between the three groups when the smoking words were at the top location. When smoking words were presented in the bottom location active smokers had significantly faster probe reaction times than non-smokers. Active smokers and abstinent smokers probe detection latencies did not differ. The analysis of word position for each group revealed that only non-smokers had significantly faster probe detection reaction times for probes in the top location compared to probes in the bottom location.

Finally, the critical three-way interaction between smoking status, word position and probe position was not significant (F (2,80) = 2.00, *MSe* = 2.76, $p > 0.05$) indicating that smoking status did not result in a shift in visual attention towards the location of smoking-related words.

Figure 8.4. Probe detection latencies for the Smoking status by word position interaction.



Anxiety measures

The anxiety data are presented in Table 8.3. Observation and analyses of mean differences showed that here were no significant differences between the three groups (F (2,81) = 0.05, *MSe* = 105.62, p > 0.05). However, the groups had significantly different session two state anxiety scores (F (2,81) = 4.76, *MSe* = 117.21, p < 0.05).

Table 8.3. Anxiety scores by group.

Anxiety/session	Group	Mean	SD
Trait	Abstinent smokers	39.91	8.10
	Active smokers	40.70	11.21
	Non-smokers	40.62	11.51
State anxiety (session two)	Abstinent smokers	42.81	10.68
	Active smokers	37.95	11.87
	Non-smokers	34.21	10.02

A post hoc Tukey's LSD test showed that the abstinent smokers did not significantly differ from active smokers, but abstinent smokers did have significantly higher state anxiety than non-smokers. Finally, the active and non-smokers state anxiety scores were not significantly different.

Self-report measures

Self-report data for abstinent and active smokers are presented in Table 8.4. Analyses of the want-cigarettes data revealed that abstinent smokers had higher levels of cigarette craving (t (54) = -4.48, p< 0.05) and were thinking more about cigarettes (t (54) = -3.27, p< 0.05). However, they did not differ in the extent to which the Dot Probe task made them think about smoking (t (54) = -0.37, p > 0.05).

Table 8.4. Cravings scores by group.

Group/self report	Session two	
	Mean	**SD**
Abstinent smokers		
Want-cigarettes	2.93	1.90
Think-cigarettes	3.06	1.91
Task and thoughts	4.20	2.46
Active smokers		
Want-cigarettes	5.45	2.28
Think-cigarettes	5.04	2.61
Task and thoughts	4.50	2.47

Correlation analyses

Multiple Pearson's correlation analyses were performed for active and abstinent smokers separately. For the active smokers (see Table 8.4) it was found that state anxiety was significantly related to Dot Probe reaction times for each combination of probe and word position. This finding suggests that active smokers who were experiencing higher levels of anxiety provided slower reactions to probes which appeared in same and different locations to smoking words. Therefore, anxiety had the effect of slowing responses to all probes. Finally, a significant negative correlation was found between the SMQ-relaxation sub-scale and state anxiety.

For the abstinent smokers (see Table 8.6) the analyses revealed a significant correlation between reaction times for the smoking word top / probe bottom trials and the 'task and thoughts' measure. This finding suggests that those abstinent smokers who reported that the Dot Probe task made them think about smoking provided slower reactions to probes. This indicates that some abstinent smokers demonstrated an attentional shift towards smoking words and away from control stimuli. No other significant correlations were found.

Table 8.5.Correlations among SMQ sub-scales, cigarette craving, Dot Probe and thoughts anxiety and probe reaction times. (Active smokers only N=24).

	VARIABLE	1	2	3	4	5	6	7	8	9	10	11
1	Want a cigarette	1.00										
2	Thinking of a cigarettes	.76**	1.00									
3	Dot Probe and thoughts	.28	.40*	1.00								
4	State anxiety (session two)	-.24	-.11	-.30	1.00							
5	Trait anxiety	-.03	.07	-.04	.65**	1.00						
6	SMQ-Relaxation	.14	.04	.12	-.45*	-.33	1.00					
7	SMQ-Sedative	-.10	.12	-.14	.12	.17	.36	1.00				
8	Smoking word top Probe top	-.14	-.07	-.27	.59**	.20	-.04	.14	1.00			
9	Smoking word top Probe bottom	-.24	-.23	-.36	.68**	.28	-.18	-.02	.81**	1.00		
10	Smoking word bottom Probe top	-.20	-.18	-.35	.41*	.09	-.06	.20	.78**	.77**	1.00	
11	Smoking word bottom probe bottom	-.15	-.11	-.24	.66**	.27	-.06	.23	.80**	.83**	.79**	1.00

(* = correlation significant at 0.05 level. ** = significant at the 0.01 level).

Table 8.6. Correlations among SMQ sub-scales, cigarette craving, anxiety, Dot Probe and thoughts and probe reaction times. (Abstinent smokers only N=32).

	VARIABLE	1	2	3	4	5	6	7	8	9	10	11
1	Want a cigarette	1.00										
2	Thinking of a cigarettes	.82**	1.00									
3	Dot Probe and thoughts	.32	.40*	1.00								
4	State anxiety (session two)	-.22	-.18	.12	1.00							
5	Trait anxiety	.06	-.11	.11	.45**	1.00						
6	SMQ-Relaxation	-.15	-.25	.03	.04	.25	1.00					
7	SMQ-Sedative	-.09	-.06	-.18	.26	.11	.34	1.00				
8	Smoking word top Probe top	-.05	.15	-.15	-.06	-.22	-.05	.18	1.00			
9	Smoking word top Probe bottom	-.23	-.00	-.39*	-.06	-.08	-.06	.18	.84**	1.00		
10	Smoking word bottom Probe top	-.05	.09	-.22	-.17	-.26	.06	.27	.76**	.69**	1.00	
11	Smoking word bottom probe bottom	.01	.20	-.12	-.01	-.27	-.28	.16	.72**	.73**	.69**	1.00

(* = correlation significant at 0.05 level. ** = significant at the 0.01 level).

Analysis of awareness and probe detection latencies

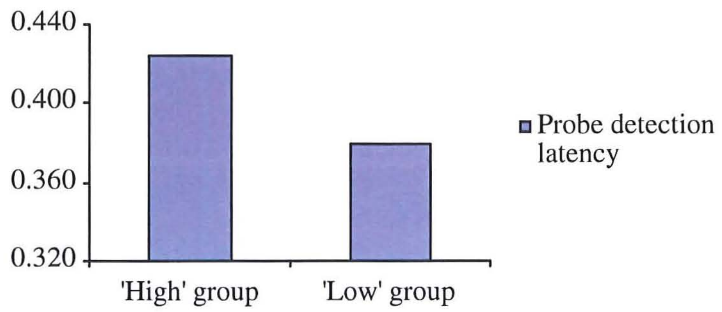
As an interesting adjunct abstinent and active smoker groups were collapsed and then dichotomised into 'high' and 'low' thinking about smoking groups. Justification for this procedure was based upon the association between 'task and thoughts' and Stroop reaction times found in Study Four. The mean reaction times are presented in Table 8.7.

Table 8.7. Probe detection latencies by word position, probe position and group.

Group by area of probe	Smoking word in upper area		Smoking word in lower area		All	
	Mean	SD	Mean	SD	Mean	SD
High 'Task and thoughts'						
Probe upper area	0.405	0.61	0.423	0.93	0.414	0.70
Probe lower area	0.439	0.74	0.430	0.93	0.434	0.76
All	0.421	0.62.	0.426	0.84	0.424	0.69
Low 'Task and thoughts'						
Probe upper area	0.369	0.103	0.367	0.110	0.368	0.101
Probe lower area	0.381	0.100	0.399	0.98	0.390	0.93
All	0.375	0.96	0.383	0.100	0.396	0.95

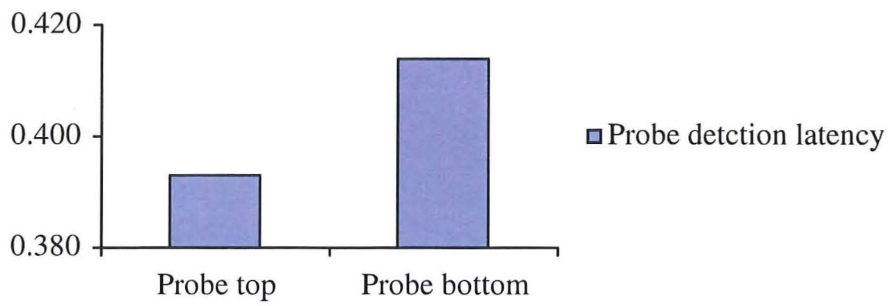
A three-way ANOVA was performed on thoughts about smoking, probe position and word position. As can be seen in Figure 8.5 there was a main effect for the thoughts about smoking factor showing that the 'high' thoughts group produced significantly slower overall probe detection latencies than the 'low' group ($F (1,54) = 4.09$, $MSe = 2.77$, $p < 0.05$).

Figure 8.5. Probe detection latencies for the 'thoughts about smoking' main effect



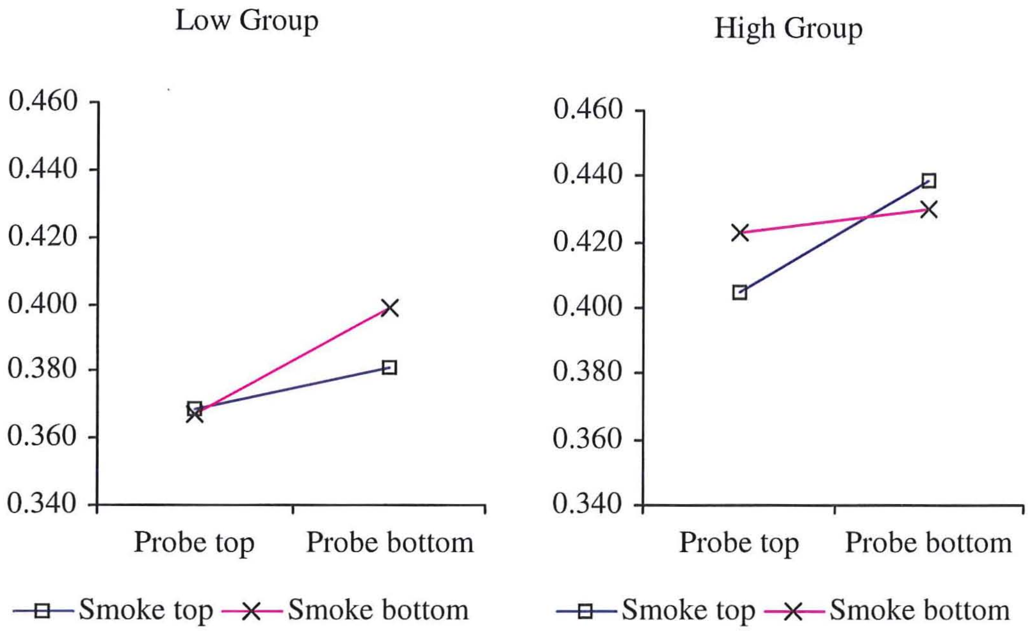
No main effect of word position was found (F (1,54) = 0.89, *MSe* = 2.46, $p > 0.05$), but a significant main effect of probe position was observed (F (1,54) = 10.98, *MSe* = 2.22, $p < 0.05$). This main effect (see Figure 8.6) shows that probes presented in the lower position resulted in slower responses. As the instruction was to read out the top word for each trial this result is consistent with the design of the task.

Figure 8.6. Probe detection latencies for the Probe main effect.



Analyses of the interactions showed no group by word position (F (1,54) = 0.07, *MSe* = 1.57, $p < 0.05$) or group by probe position effects (F (1,54) = 0.00, *MSe* = 1.57, $p > 0.05$). There was also no interaction between word position and probe position (F (1,54) = 0.15, *MSe* = 1.57, $p > 0.05$). However, the critical interaction between probe position, word position and thoughts about smoking was significant (F (1,54) = 4.90, *MSe* = 1.57, $p < 0.05$).

Figure 8.7. Overall three-way interaction of group by word position by probe position.



In order to understand the three-way interaction (see Figure 8.7) simple interaction effects analyses were performed. The simple interaction effects analyses for the effect of group are presented in Table 8.8. These show that group status was not significant for any of the combinations of word and probe position. However, the effect of group approached significance when the probe was presented in the top location and the smoking word was in the bottom location. This suggests that the high groups were shifting attention towards smoking words.

Table 8.8. Simple interaction effects analyses for thoughts about smoking at word by probe position.

Thoughts about smoking (Highs vs. Lows)	F	p
Word top		
Probe top	1.18	0.27
Probe bottom	3.12	0.08
Word bottom		
Probe top	2.86	0.09
Probe bottom	0.88	0.34

Inspection of Table 8.9 shows no significant effects of word position across levels of thoughts about smoking and probe position. However, Table 8.10 shows that the high ‘thoughts and task’ group probe reaction times were significantly slower when probes were presented at the bottom location and smoking words were presented at the top location.

Table 8.9. Simple interaction effects analysis for word position by group by probe position.

Word position (Top vs. Bottom)	F	p
‘High’ group		
Probe top	2.15	0.15
Probe bottom	0.56	0.45
‘Low’ group		
Probe top	0.01	0.91
Probe bottom	1.61	0.20

However, no differences between probe position were found when the smoking words were in the bottom position. Analyses of probe position in the low thoughts about smoking group showed opposite effects (see Table 8.9). When the smoking words were presented in the top location no significant difference was found between top and bottom probe reaction time.

Table 8.10. Simple interaction effects analysis for probe position by group by word position.

Probe Position (Top vs. Bottom)	F	p
‘High’ group		
Word top	8.20	0.00
Word bottom	0.29	0.59
‘Low’ group		
Word top	0.80	0.37
Word bottom	5.51	0.02

However a predictable non-vigilant effect was observed when the smoking word was presented at the bottom location. Overall, these effects suggest that those participants who were thinking about smoking showed an attentional bias to the smoking stimuli. These findings are interpreted in the discussion section.

8.3 Discussion

The main aim of this study was to examine the effects of abstinence on the attentional processing of smoking words in a Dot Probe task. Furthermore, this study also investigated the effects of abstinence on state anxiety, self reported craving for cigarettes and the relationship between probe detection latencies, cravings, anxiety and smoking motivation. Finally, the effects of awareness on visual attention for smoking words were investigated.

The main analysis of the Dot Probe data revealed a significant main effect of word position and probe position, and a significant interaction between word position and probe position. This result is consistent with the task requirement to read out loud the word at the top location (MacLeod et al. 1986; Broadbent et al. 1988; MacLeod et al. 1988; Mogg et al. 1995). Thus, participants conformed to the task instructions and responded slower when probes were presented in the bottom location. Furthermore, a main effect for smoking status was found which revealed a significant difference between the active smokers and non-smokers for probe detection latencies. Non-smokers were the fastest at detecting probes, indicating that they performed the task with the least amount of disturbance on the central task of naming the top word and responding to probes. Active smokers performed faster than abstinent smokers on the task. This may reflect a detrimental effect of nicotine abstinence on reaction time performance in this condition.

Analyses also revealed a significant interaction between smoking status and word position, such that when smoking words were presented in the bottom location active smokers had significantly faster probe reaction times than non-smokers. Further analyses revealed that non-smokers had significantly faster probe detection reaction times for top versus bottom location. However, the critical three-way interaction involving smoking status with word position and probe position was not significant. This null finding indicates that abstinent smokers did not shift their attention towards smoking words. Overall, these findings show that the Dot Probe task was effective but the key experimental manipulation (smoking abstinence) did not result in an attentional bias.

One possible explanation for this finding is that abstinent smokers demonstrated avoidance for smoking words. A similar finding was reported by Mogg et al. (2000) in an examination of a non-clinical sample of low anxiety repressors. Here it was found that high levels of defensiveness in combination with low trait anxiety were associated with greater avoidance of threat on a Dot Probe task. In the context of the present study it could be argued that smokers demonstrated a conscious avoidance strategy to smoking-related stimuli. This interpretation of the data is also consistent with the findings that abstinent smokers reported that the task made them think about smoking. Thus, it is possible that non-clinical samples are characterised by avoidance of self-referent material as opposed to anxious samples who show vigilance for relevant stimuli.

Analyses of the craving and thoughts about smoking data replicated the findings of previous studies in this thesis. As expected, higher levels of anxiety, craving and thoughts about cigarettes were found in smokers who underwent six hours of abstinence. This result is in line with the prediction arising from Tiffany's cognitive model of drug use and accords with the findings from Gross et al.'s (1993) study. Furthermore, the CO analysis confirmed the effect of abstinence on expired air CO levels. Carbon monoxide levels were significantly lower in abstinent smokers that active smokers.

The correlation analyses revealed that for the active smokers' higher levels of state anxiety resulted in slower reaction times for all probes. This finding concurs with the studies of processing bias presented in previous chapters. For the abstinent smokers it was found that reaction to probes that appeared in a different location to a smoking word were significantly correlated to the 'task and thoughts' measure. This finding suggests that those abstinent smokers who reported that they were thinking more about cigarettes during the performance of the Dot Probe task provided slower probe detection latencies.

As an adjunct to the abstinence hypothesis awareness of smoking was assessed independently to whether the participant had abstained from smoking. Abstinent and active smoking participants were divided into two groups (high or low) on the 'task and thoughts' measure. When this factor was entered into a mixed ANOVA it was found that the group factor (high / low thoughts) significantly interacted with word position and probe position. Further analyses showed that those who reported more thoughts about smoking had slower reaction times to probes that were presented in different locations to smoking-related words. The findings for the 'low' group revealed an opposite pattern of responses. This suggests that those smokers who reported that they were aware of smoking concepts whilst performing the Dot Probe task were experiencing a shift in visual attention towards the location of smoking-related words. From this finding it could be concluded that the 'high' group of smokers were conscious of their attentional shift towards smoking-related terms and they reported that they thought more about smoking after completing the task. Those smokers who reported that they did not think much about smoking following the task, did not exhibit a pattern of responses which indicated a shift in visual attention towards smoking-related words. This finding is discussed in the context of the present thesis in the final chapter.

8.4 Conclusions

This final study did not find the predicted effect of shift in visual attention towards smoking words in abstinent smokers. Although abstinent smokers were slower at responding to probes, there was no evidence of attentional bias. However, a supplementary analysis of the role of awareness in the processing of smoking words did reveal some interesting and pertinent findings. Only smokers who reported that they were aware of smoking concepts during their performance of the Dot Probe task showed a shift in visual attention towards the location of smoking words. Unaware smokers did not. Therefore, from this analysis and the findings in Chapters Six and Seven it is apparent that cognitive biases are not simple phenomenon. The implication is that attentional bias is a product of automatic and strategically controlled processing and that smokers may demonstrate attentional avoidance for smoking stimuli under Dot Probe conditions.

Chapter Nine
Conclusions

9.1 Introduction

The main aims of this thesis were to investigate the cognitive and attentional processing of smoking-related words in smokers. This chapter will discuss the results from the empirical chapters in relation to cognitive theories of smoking behaviour and in the context of previous, present and future research into smoking. This chapter will also examine the implications of these findings for smoking cessation interventions, and argue that in order to increase the efficacy of interventions consideration of data from cognitive studies of drug use behaviour needs to be made. Furthermore, issues of Stroop methodology, the development of the Dot Probe task and the difficulties of carrying out smoking abstinence research will be critically discussed along with an outline of future research and recommendations for further development of the present research project.

A strong motivation for the development and implementation of the research presented in this thesis was outlined in Chapter One. Here it was shown that the majority of research into smoking was derived from two antithetical schools. The first, the biological model of addiction emphasised the role of nicotine and pharmacological factors in smoking behaviour. The second, the social learning model of addiction sought to explain drug use by recourse to a set of social psychological variables. Whilst both approaches offer useful epistemologies neither is able to show useful insights into attentional and cognitive biases indicative of smoking addiction. Contemporary social learning theory has traditionally conceptualised addictive behaviours as being characterised by biased thinking, relating to individuals expectancies of drug use and low levels of self-efficacy. Much of the research to date has supported the argument that addicted individuals demonstrate biases in positive and negative outcome expectancies, such that they inflate the former and deflate the later (Bennett & Murphy, 1999). They also show that self-efficacy and belief in the ability to overcome the addiction or cope with its effects are significant barriers to change (Schwarzer & Fuchs, 2001). However, social learning models have not considered the role of cognitive processing of smoking-related stimuli in drug use behaviour. Furthermore, social learning accounts of addictive behaviour have largely developed through the collection of self-report data measuring beliefs, cognitions and outcome expectancy. To this end they have been generally reliable and efficient. However, the ability to determine the full extent of the role of cognitive processes in addictive behaviours may be limited by the measures used. For example, there is evidence suggesting that self-reported expectancy judgements can change in response to drug-related cue exposure (Cooney, Gillespe, Bakr & Kaplan, 1987). It has also been argued that individuals modify responses based on their evaluation of their behaviour in relation to whether they think a statement is negative or positive and how they would wish to be seen (Stacy, 1997). Finally, drug users may not be able to produce verbal reports of drug-related cognitions, related to attentional processing and automatic processing of semantic material. There may well be important processes that govern drug use behaviour which are outside of conscious awareness and inaccessible through retrospective self-report. Such limitations have prompted researchers to develop alternative approaches aimed elucidating the role cognitive biases in the addictions. It was the awareness of this development that prompted the research for the present thesis, and the desire to conduct research into this new and important project.

The evidence for cognitive biases in addiction has been discussed by McCusker (2001) who observed that theorists who have attempted to investigate cognitive biases in the addictions have drawn from spreading activation models of memory, schema theory, implicit cognition, and neural network theory. The extent to which the integration of these various cognitive approaches have been effectively integrated into addiction theory is reflected in a statement by McCusker (2001) where he argues; '*it is probably also fair to say that a specific model of cognitive biases in the addictive behaviours, derived from this class of theories is still in an emergent stage'*, p53. The adoption of a new approach to study cognitive biases in the addictions has been a fairly recent development and as McCusker observes, it is in its infancy. As outlined in Chapters One, Two and Three there are only a handful of studies that have utilised the specific measures and approaches detailed in the present thesis to study smokers processing of smoking-related stimuli (Gross et al., 1993; Johnsen et al., 1997; Waters & Fayerband, 2000). After a literature review it was considered appropriate to focus on the findings of the Gross et al. (1993) paper, and that this work would be a good starting point for the development a program of experimental studies testing several hypotheses. Firstly, in what circumstances do smokers exhibit a processing bias for smoking-related stimuli? Secondly, does abstinence increase state anxiety and increase cravings for cigarettes? Lastly, to what extent is the processing of smoking-related stimuli influenced by individual factors such as motivation to smoke cigarette dependence and smoking demographics?

Prior to the testing of these hypotheses it was deemed necessary to examine the type of stimuli and the range of self-report measures used in smoking research. This was the purpose of Chapters Two and Three. The focus of attention was on smoking-related words and those measures that evaluate smoking motivation, and anxiety. In summary, it was argued that smoking-related words were best suited to the two main dependent measures used to measure processing bias, namely the Stroop and Dot Probe tasks. Measures of smoking motivation and anxiety were examined and the SMQ and Spielberger STAI identified as appropriate measures of smoking motivation and anxiety. Prior to examination of the hypotheses a set of UK-based smoking-related words was required. Furthermore, given the small amount of studies that had examined the factor structure and internal reliability of the SMQ it was necessary to carry out a preliminary study aimed at examining the structure and internal reliability of the 27-item SMQ. These were the aims of the first empirical chapter. The findings are briefly evaluated below.

Prior to the commencement of the present thesis no UK-based smoking-related word lists were available for use. Although an American-English list was available (Gross et al., 1993) it was argued that a UK-based list was required in order to ensure that the participants in the experimental studies would be familiar with the words used in future reaction time tasks. Study One was successful in producing a viable set of smoking-related words together with a set of control words. When the smoking-related words and control words were used in three Stroop studies it was found that the first Stroop task produced no overall Stroop effect. It was also found that no interference was created by smoking-related or control words in active smokers. The second Stroop study used the same Stroop protocol as the first and this time an overall Stroop effect was found. However, no interference effects were found for smoking-related words in abstinent or active smokers. A final card-based Stroop did reveal a significant interference effect for smoking-related words in abstinent smokers. Finally, when using the smoking-related words and control words in a Dot Probe task it was found that abstinent smokers did not automatically shift their attention towards smoking-related words, or away from control words. However, further analysis did reveal that those smokers who reported being conscious of the smoking-related items during the performance of the task shifted their visual focus towards the location of smoking-related words. Therefore, the present thesis has failed to present a consistent pattern of results on cognitive and attentional bias in smokers.

9.2 Discussion of the Stroop results

In the first Stroop experiment smokers and non-smokers reactions to smoking words were evaluated using a single trial computerised version of the Stroop task. Contrary to predictions the analysis revealed that no Stroop interference effect was produced. Furthermore, no processing bias was apparent in smokers. Several explanations were given for these findings. It was possible that the active smokers did not exhibit a cognitive bias for smoking words. However, given that there was no interference effect observed this hypothesis could not be evaluated effectively. To explain the lack of Stroop effect it was argued that the participants in the study may have been able to exercise an override strategy, enabling them to perform the task without being distracted by the smoking words. This interpretation is supported by evidence suggesting that under some circumstances participants performing Stroop tasks may be able to employ techniques to reduce the influence of the task (Lavy & van den Hout, 1993; Williams, 1996). As a consequence a second experiment was conducted that examined the processing of smoking words in abstinent, active and non-smokers. This tested the hypothesis that abstinence produces a cognitive bias for smoking words. The results showed a significant Stroop effect, confirming the effectiveness of the design in the context of the first experiment. However, abstinent smokers' reaction times for smoking words were not significantly different from control words. To explain this finding it was argued that the participants may have been able to employ an explicit override strategy to nullify interference caused by the smoking words. Furthermore, there is evidence to support the argument that single trial forms of the Stroop task do not allow rumination to occur and are therefore not as sensitive as blocked versions of the task (Kindt, 1996; Holle, 1997). In the light of this evidence a further Stroop study was conducted using a card-based Stroop protocol.

The final Stroop study adopted the card-based modified Stroop task used by Gross et al. (1993). This was done in order to more closely match the method used in this study and because the card-based Stroop has the advantage of producing a greater interference effect than single-trial manual response versions of the task. It was found that following six hours of abstinence smokers demonstrated a cognitive bias for smoking words. Reaction times for colour naming smoking words were significantly slower than for control words. No differences were found in the other groups. Thus, this study provided evidence that short-term abstinence brings about a cognitive bias for smoking-related stimuli. The results stand in contrast with the findings from Study Four suggesting that cognitive bias is only exhibited in card-based versions of the Stroop task. This may be because the card-based Stroop protocol could have made participants focus attention on the smoking words. In contrast, abstinent participants in the single trial randomised Stroop protocol may have been able to avoid the processing of smoking words and evade interference on the central task. Further evidence in support of this interpretation comes from a recent study of the determinants of cognitive bias in smokers (Waters, & Feyerabend, 2000). In this study an emotional Stroop task was presented in blocked (smoking and neutral words presented in separate blocks) and unblocked format (smoking and neutral words presented in a random sequence). It was found that 24 hours of abstinence created a processing bias for smoking words detected by the blocked but not the unblocked format of the Stroop task. Therefore, this study provides further evidence for the pattern of results obtained in the present thesis.

Overall findings point to some important issues regarding the nature of processing bias in abstinent smokers. Firstly, they suggest that processing biases in motivational states do not mirror biases in emotional disorders. As research has shown clinical anxiety states are characterised by a hypervigilance for threat-related stimuli. As a consequence high trait anxiety influences the direction of pre-attentive and attentional biases to threat stimuli. High trait anxiety leads to orienting towards threat whereas low trait anxiety leads to an avoidance of threat stimuli. Furthermore, state and trait anxiety interact such that high trait-state anxiety leads to increased vigilance for threat, and low trait anxiety individuals who are state anxious show avoidance for threat (Mogg & Bradley, 1998). Although the present thesis has shown that abstinence increases state anxiety, the levels were not comparable to clinical populations. Therefore, it is not possible to argue that the abstinent smokers' cognitive bias was a function of state and trait anxiety increasing vigilance for the smoking-related stimuli. Rather, the processing bias observed may result from the activation of drug congruent schema which facilitate the processing of smoking-related stimuli in a conscious and controlled manner. This interpretation is supported by evidence from Jarvik et al. (1995) who demonstrated enhanced lexical processing of smoking stimuli during smoking abstinence. In addition Rosenblatt et al. (1996) has demonstrated that abstinence enhances memory for cigarette advertisements. Both these studies confirm that abstinence facilitates the processing and recall of smoking-related stimuli and that such biases in processing are independent of anxiety.

If research into the other addictions is considered there is further support for the aforementioned interpretation. Automaticity in cognitive biases and automatic preoccupation with addiction-related information is evident from a number of studies in alcoholics (Sharma, Albery & Cook, 2001; Bauer & Cox, 1998), drug users (Franken et al., 2000; Lubman et al., 2000) and gamblers (McCusker & Gettings, 1997). All of these studies suggest that interference on the Stroop task is due to automatic cognitive processes, and that this automatic processing compromises individuals ability to intentionally colour name. These studies suggest that there is a non-volitional cognitive bias for the processing of addiction-related stimuli associated with addictive behaviours (McCusker, 2001). However, the evidence from the present thesis suggests that subjective awareness of bias for smoking-related stimuli can effect the ongoing processing of such material. The data from the card-based Stroop suggests that cognitive bias is heightened by a participant's awareness of smoking-related stimuli. This may be an artefact of the task demands or may be an occurrence of abstinence, or both. The suggestion is that card-based versions of the Stroop may allow time to ruminate on the meaning of the words presented and this produces an interference effect. On the other hand interference may be directly due to abstinence effects on cognitive processing which is increased by the opportunity to ruminate on smoking-related words.

9.3 Problems with Stroop methodology

Despite the fact that the Stroop task has shown its worth in investigations of psychopathology (Williams et al.,1996) and shows promise in the context of addictive behaviours (McCusker, 2001; Waters & Feyerabend, 2000; Faunce & Job, 2000; Cox, Pothos & Bauer, 2000) it is obvious from the results of the present thesis and discussions by others (Faunce & Job, 2000; Cox et al., 2000) that there are inconsistencies in Stroop findings. Research suggests that these are related to various protocols. Two main aspects are considered here. Firstly, the difference between blocked and unblocked versions of the Stroop task and secondly, the impact of different response modes on Stroop interference.

In a comprehensive review of the Stroop task in psychopathology Williams et al. (1998) assessed studies that used the Stroop task to study attentional bias in psychopathology. Of these studies 29 had used a traditional card-based version of the task, and two had used a computerised 'VDU' card presentation format. The remainder had used either a blocked or unblocked task with or without randomisation. They found that a traditional card version created greater interference than computerised single trial tasks. They also conclude that the Stroop task is important in establishing the extent to which attentional bias is involved in psychopathology, and that interference observed in these cases is not due to artifactual variables such as priming effects, the effects of practice or the presentation format.

Sharma and McKenna (1998) have offered a more fine-grained analysis of Stroop format effects. They sought to examine the difference between a card format and single-trial format of the Standard colour-word Stroop task and the emotional Stroop task. The results showed that there was no convergent validity for the card format and single-trial format of the standard Stroop task, and that this was also the case for the emotional Stroop task. This analysis suggests that the two formats of the task measure different mechanisms. The single-trial format of the task may engage another selective processing mechanism that produces a different kind of interference from that caused by a task which involves the target and its colour being integrated. This is consistent with the general finding mentioned earlier that blocked versions of the task produce greater interference than single-trial formats involving a separation of stimulus word and colour. Therefore, the finding from the present thesis that a separated singe trial format of the task produced no significant interference effects, but a traditional card-based vocal response task did, is consistent with other research findings. It may be concluded that it is more difficult to inhibit the processing of colour-related information in favour of smoking-related stimuli when the target and colour are integrated than when they are not.

As mentioned in the previous section Waters and Feyerabend (2000) conducted a study aimed at replicating Gross et al.'s (1993) findings of cognitive bias for smoking-related words in abstinent smokers. They also examined the differential findings from a single trial and blocked Stroop presentation. The main analysis supported the Gross et al. (1993) effect. Abstinent smokers showed bias for smoking-related words. However, it was also found that smokers colour naming of smoking-related words was slower than neutral words in a blocked condition but not in an unblocked condition. The results indicated that abstinent smokers colour naming of neutral items was slowed when they were presented with smoking items. There also seemed to be a carry over effect operating which caused a slowing of responses to neutral items when they followed smoking-related items. Waters and Feyerabend (2000) conclude that blocking is an important variable in the emotional Stroop task and that blocked and unblocked formats are essentially different instruments that give rise to fundamentally different results.

Now the issue of response modes and Stroop effects are discussed. The findings from the present thesis have not only highlighted the importance of presentation format for Stroop tasks but also the role played by different response modes in Stroop interference. The present thesis used two different response modes. Manual response via computer keyboard keys and timed vocal responses. For the first single trial manual Stroop study there was no overall Stroop interference found. The second Stroop study used the same protocol and did find a standard Stroop effect but no interference was generated by the smoking-related stimuli. The final Stroop study used a vocal card-based Stroop and revealed a significant Stroop interference for smoking-related words. In relation to the present discussion some interesting findings were obtained in a study by Albery and Cook, (2001). They conducted a study of selective attentional bias in problem drinkers to test their main hypothesis that problem drinkers have a selective bias for alcohol-related stimuli. They used a single trial Stroop format with responses measured by colour identified response keys. They found a Stroop effect for problem drinkers using this protocol. They analysed for carry over effects and concluded that they were not apparent using this protocol. Thus, they were able to show that data from studies using vocal responses can be generalised to a study using a manual version of the single trial Stroop. Of the addiction-related Stroop studies published three used a vocal response to measure interference (Gross et al., 1993; Johnsen et al., 1997; Bauer & Cox, 1998), and one used a manual response measure which involved participants pressing four coloured keys (Sharma, Albery & Cook, 2001). The vocal response study and the manual response study found significant Stroop effects, which suggests that both response modes are effective in measuring interference effects in this context.

Due to inconsistencies in the Stroop data it is not possible to be other than tentative in making conclusions concerning cognitive bias in smokers. Reflecting on the state of research in the addictions Faunce and Job (2000) argue that the development of research into cognitive biases in the addictions is in its infancy and that one significant issue that impedes the development of research concerns the nature of the Stroop effect. This situation is mirrored in the anxiety literature where there has been much debate concerning the utility of the Stroop task as a measure of cognitive or attentional bias. The arguments have highlighted the fact that Stroop interference may be generated by different cognitive mechanisms. It may be that it is caused by participants biased processing of self-referent stimuli in the visual field that disrupts the central task of colour naming. Or it may be that disruption of colour naming is brought about by a shift in attention to another point in the visual field. The Stroop effect is such that it is impossible to differentiate between these two possible explanations at the level of task performance as cognitive bias or visual attentional bias could both cause Stroop interference. Whether vocal or manual responses are used, neither will be able to determine which is operating to produce interference. It was for this reason that the final study used the less ambiguous Dot Probe measure to further investigate attentional bias in smokers. In support of this decision Faunce and Job (2000) argue that more direct measures of attention are required to determine the exact nature of addiction-related biases. As has been outlined in the present thesis the Dot Probe provides for a more direct measure of selective attention. Faunce and Job (2000) also argue that future research should adopt the Dot Probe task in studies of addition-related biases and should consider the possibility that there may be critical differences between anxiety states and addictive behaviours which determine different attentional effects in these two conditions.

9.4 Dot Probe results

The present thesis sought to examine both cognitive bias and attentional bias in abstinent smokers. The former task was achieved with variable success using two formats of the Stroop task, and an evaluation of attentional bias was performed using a Dot Probe task in the final study. It was hoped that this task would be a more direct index of visual attention and was used in order to clarify the effect of abstinence on smokers visual orienting towards smoking-related stimuli that was not possible from the Stroop data. Although the analyses showed that the task was measuring selective attention the critical interaction effect between group status, word position, and probe position was not significant. However, correlation analyses found a significant relationship between reaction time and self-reported thoughts prompted by the Dot Probe task. Increases in reaction times were found in those participants who reported that the Dot Probe task made them think about cigarettes. A subsidiary analysis was carried out using a median split procedure to divide smoking participants into high and low groups on the 'task and thoughts' measure. This factor was entered into an analysis of the probe reaction times that revealed the aforementioned significant three-way interaction. Further analyses showed a predictable pattern of results consistent with the argument that smokers reporting awareness of smoking during the task shifted their visual attention towards the location of smoking words.

Evidence from Broadbent and Broadbent (1988) who have investigated attentional biases in non-clinical anxiety groups may shed some light on the present findings. Broadbent and Broadbent (1998) used a Dot Probe task with emotionally threatening words to study the effects of anxiety on the distribution of visual attention for threat-related stimuli. It was found that only anxious participants shifted their visual attention towards the emotionally threatening words but that non-anxious participants did not. However, it was observed that attentional shift was a function of trait anxiety, such that at lower levels of trait anxiety the effect was not observed but at higher levels it was. Moreover, it was also observed that the effect was not only related to the type of threat related material presented (and the level of trait anxiety) but that attentional bias built up during the testing period and was due to increased post-attentive awareness of threat-related material. This evidence is consistent with the above interpretation of the processing of smoking-related material. Given that the Dot Probe task required participants to read out the top word on every presentation of word pairs, it would be reasonable to assume that reading out loud half of the smoking-related words would result in a conscious awareness of the smoking-related words. Being aware of the presence of smoking-related words could therefore act as a signal to the participant that a probe was likely to appear, either in the top or bottom location. Whichever happened, the participants may have become aware that the presence of the smoking-related word would be followed by a probe, and therefore the bias that was observed in the smokers could have been a result of a change in strategy during the task. Therefore, it is possible that smokers normally avoid smoking-related words if task conditions make it possible, but when they become consciously aware of smoking concepts avoidance turns into a visual bias for smoking stimuli. However, as the aim of the present study was to investigate the effects of abstinence on attentional processing further research is required to verify this interpretation.

A summary of the findings suggests that cognitive and attentional bias to smoking words may be dependent on several factors. Firstly, the data from the single trial Stroop studies suggest that they may not be sensitive to abstinence effects on smoking word processing. However, a card-based format provided evidence of a cognitive bias to smoking-related stimuli in abstinent smokers. In contrast, the Dot Probe task did not reveal that abstinent smokers visually attend to smoking-related words. Instead, a subsidiary analysis showed that smokers who were consciously aware of smoking during the performance of the task visually attended to smoking words. This suggests that when smokers are performing a task in which they are forced to process the smoking words to a deeper extent (card-based Stroop) they show a processing bias for smoking words. If they are performing a task that requires a response to a neutral non-valenced probe (Dot Probe) they show a pattern of avoidance for smoking words. However, if the task demands create an awareness of smoking words (through the association between probes and smoking words becoming apparent during the task) then smokers will show a shift in attention towards smoking words. To speculate, perhaps the threshold of reactivity to smoking cues is lowered in those smokers who become aware of smoking concepts and as a result they are then unable to counteract the development of a processing bias.

9.4.1 Development of the Dot Probe task

In the context of the addiction research Faunce and Job (2000) support the notion that the Dot Probe task is a more direct measure of selective attention. They say; 'the advantage of the dot probe task is that it is able to circumvent the conventional criticisms of the emotional Stroop task, and is able to provide more precise information on the allocation of visual attention during exposure to target words' p. 1439. So the utility of the task in measuring attentional bias in addictions is recognised. However, before the development of the Dot probe task is contemplated replication of the present Dot Probe study needs to be conducted to address the anomalies found in the present thesis. Replication should seek to establish whether abstinent smokers shift attention towards smoking-related stimuli, and to further investigate the suggestion from the present thesis that this shift is related to smokers' awareness of smoking-related words. Following replication of the present Dot Probe study further research on the attentional processing of drug-related information could be pursued. This would be best served by using the Dot Probe task either by using word or pictorial drug-related stimuli. This has been done by Lubman et al. (2000) who studied attentional bias in opiate abusers using a pictorial Dot Probe task. It was found that opiate abusers shifted attention to drug cues whereas non-users didn't. Other studies have successfully adopted the Dot Probe task in areas outside of the anxiety field. Rieger, Schotte, Touyz, Beumant, Griffiths and Russell, (1998) assessed attentional biases in eating disorders, and found biases that favored the processing of stimuli connoting a thin physique, and Franken, Kroon and Hendriks, (2000) found that cocaine abusers showed attentional bias for cocaine-related stimuli using a Dot Probe task.

Even though Cox, Pothos and Bauer, (2000) have suggested that Dot Probe task findings are subject to alternative explanations they do concede that the most plausible interpretation of the effect is in terms of selective attention. They also agree with Faunce and Job (2000) that the development of addiction research should mirror the developments seen in the anxiety research and adopt the Stroop task and the Dot probe tasks as measures of cognitive and attentional bias. This would be in order to define the common and uncommon mechanisms that underlie psychopathology and addictive behaviours. In all, these studies support the utility of the Dot Probe task in measuring individual differences in the processing of addiction-related material and point to its use as an index of intervention effects. In the context of smoking it would be useful to establish the sensitivity of the Dot Probe task to smoking interventions and in particular to the effects of Nicotine Replacement Therapy (NRT). In this respect it would be useful to examine whether NRT therapy modifies smokers attentional processing of smoking-related stimuli. However, as no studies have evaluated treatment effects with the Dot Probe task its utility in this respect remains to be tested.

9.5 Word category effects

Following the use of the smoking-related and control words in the experimental studies it became apparent that the inclusion of the word "chimney' had implications for conclusions drawn from these experiments. Although care was taken over the selection of the control words so that they all related to the category of 'household items' it became obvious to the present author that the word 'chimney' could have been construed as a smoking-related word by participants in the experiments. This could have affected the results in specific ways. The following section will examine these.

In the context of the single trial manual response Stroop the influence of 'chimney' could have been such as to increase by a small amount the average reaction times for the control word category. However, all words were presented in a unique randomised order for each participant, and in this context 'chimney' would have been mixed with other control words and smoking-related words within this random order. With this presentation the participants awareness of the category that 'chimney' belonged to would have been less likely to be influenced by the presentation order of the words. Had the software used for the presentation of the words been able to remove the data for 'chimney' post hoc, then it would have been possible to randomly remove one smoking-related word and achieve a balanced set of data. A re-run the analysis may then have been able to determine the actual effect of 'chimney' on the results. As this was not possible any arguments marshalled to explain the effect can only be settled by replication with modifications. Recommendations for replications and modifications to word lists will be presented in later sections of this chapter.

For the card-based Stroop the words were presented in blocks of smoking words and control words. In this context there is a possibility that 'chimney' may have disrupted colour-naming even though it was presented within a block of household-related words. In the case where smoking words were presented before control words smokers may have been already primed for smoking words. Thus, the occurrence of the word chimney may have had an undue effect on reaction times for that group. However, no order effects involving word type were found to be significant in the analyses of the blocked Stroop data, and counterbalancing measures should have ensured that any effects produced by the word chimney would have been bilateral. Research by Williams, Mathews and McLeod (1998) is relevant to this point. They have concluded that although priming effects of one word on the next presentation of a word of the same theme could create a Stroop interference effect, colour interference is not due to such interim priming effects. This conclusion is also borne out by other research which suggests that where intercategory priming effects are controlled by having control stimuli from the same single category, interference effects still occur (Williams et al., 1998). In summary, the inclusion of 'chimney' in the control word list was a serious oversight. Some of the possible effects of this word on the present results have been discussed. It will require more research with a modified set of control words to confirm the findings of the present thesis.

9.6 Analyses of self-report variables

In addition to the investigation of the processing of smoking words the present thesis was also concerned with the effects of abstinence on anxiety and self-reported cravings for cigarettes. This was important because there was no information on the effects of short-term abstinence on anxiety in the literature. Also, data on subjective experiences during abstinence was needed to verify that smokers were experiencing cravings. Furthermore, it was the intention of the thesis to investigate the relationship between anxiety, cravings, smoking motivation, smoking demographics and smoking word processing.

When considering the impact of Stroop and Dot Probe performance on conscious awareness of smoking concepts some interesting results were obtained. In Study Four a single trial Stroop protocol was adopted and no differences were found between the abstinent and active smokers on the 'task and thoughts about smoking' measure. However, when a card-based Stroop was used in Study Five it was found that abstinent smokers provided higher ratings on the task and thoughts measure than active smokers, indicating that the experiment made them think about smoking. Furthermore, when the Dot Probe task was administered no differences between active smokers and non-smokers were found, with both groups providing ratings in the mid-range of the self-report scale. What these findings may indicate is that the single trial Stroop protocol and the Dot Probe task did not activate smoking-related schema. However, smokers who had smoking schema primed or activated by being abstinent did find that a card-based blocked words Stroop task prompted thoughts about smoking. Thus, abstinence and the focused nature of the Stroop task may have brought about an increased awareness of smoking which translated into a cognitive bias for smoking words.

In Study Three the use of self-report measures was restricted to the Spielberger STAI. In this study the predicted differences between smokers and non-smokers anxiety scores was found. Smokers had higher levels of anxiety compared to non-smokers. However, smokers were found to have higher levels of anxiety comparable to levels found in other studies (Schneider and Houston, 1970; Spielberger, 1986; Hughes, Hatsukami, Mitchell & Dahlgren, 1986; Patton, Barnes & Murray, 1993). It may have been that participation in the experiment induced higher levels of anxiety in the smokers. In studies Four Five and Six, the effects of abstinence on anxiety, self-reported cravings and thoughts about cigarettes were evaluated. Furthermore, the FTQ and the SMQ were used to obtain data on dependence and motivation to smoke. The results showed that after six hours of abstinence smokers experienced significant increases in anxiety, and cravings for cigarettes. Furthermore, increases in state anxiety were found to be related to expired air carbon monoxide levels. Overall these findings suggest that abstinence is associated with a reduction in nicotine levels and that withdrawal from smoking also increases cravings and state anxiety.

Finally, multiple correlation analyses between smoking motivation, anxiety, cravings for cigarettes, smoking demographics and smoking word processing were assessed independently for abstinent and active smokers. For the active smokers in Study Six, state anxiety was found to be positively related to probe detection latencies for all combinations of words and probe position. In Study Four it was found that that SMQ-relaxation scores were related to desire for cigarettes, and analyses in Study Four found that abstinent smokers SMQ-relaxation scores were related to incongruent smoking word reaction times. However, the interaction between SMQ-relaxation scores and type of word was not significant. Furthermore, in Study Five significant correlations were found between SMQ-sedative, SMQ–relaxation scores and the number of years smoking. The SMQ-relaxation was also related to session two state anxiety scores. Overall these findings suggest that anxiety is a key indicator of many smoking variables in active smokers.

For the abstinent smokers Study Four found that reaction times for smoking words were related to the 'task and thoughts' measure. In Study Six it was found that reactions to trials when probes appeared at the bottom location and smoking words appeared at the top location were related to the 'task and thoughts' measure. These findings provide further support for the conclusion that abstinence brings about a preoccupation with smoking and that this awareness may impact on cognitive and attentional processing. In study Four state anxiety following abstinence was significantly related to, FTQ scores, CO levels at session two and the need for cigarettes. In addition it was found that SMQ-sedative scores were related to trait anxiety scores. In Study Five it was found that state anxiety scores at session two were related to CO levels and the desire for a cigarette. Furthermore, trait anxiety was related to thoughts about smoking during the performance of the Stroop task and the number of years smoking. Finally, the number of cigarettes smoked daily was related to desire for cigarettes and thoughts about cigarettes. In summary, these results demonstrate that abstinence predicts changes in anxiety self-reported desire for cigarettes, and that changes in anxiety are related to dependence.

9.7 General consideration of results

No studies to date have measured anxiety levels in abstinent smokers and related these to attentional processing measures to determine the relationship between the two. Neither have there been any published studies that have compared abstinent smokers with generally anxious people to compare the two. In the present thesis anxiety measures were examined for their relationship with the Stroop and Dot Probe measures. The present thesis found no significant correlation between state anxiety and cognitive bias measures, suggesting that although abstinent smokers do experience increases in anxiety, this anxiety increase is not cardinal in the production of biased processing of smoking-related stimuli. Therefore, it is possible to argue that anxious individuals adopt an attentional style that is concerned with vigilance for threat and a general aim of protecting the individual from exposure to the threat-related stimuli. In the case of the smoker, drug addict or alcoholic, drug-related stimuli may not be aversive or threatening. In contrast drug-related stimuli are appetitive and as such do not pose a threat to the individual. So, attentional bias in this case may not related to the avoidance of a threatening stimulus, but rather to a preoccupation with a stimulus which is related to something that will reduce the negative affect produced by abstinence. Therefore, attentional bias during periods of abstinence may be fundamentally different from biases created by psychopathological states, such as anxiety and phobias. This argument is supported by the findings of a study by Lavy and van de Hout (1993) who found attentional bias in fasting normal subjects and concluded that attentional bias is not limited to either anxiety patients or to threat-related stimuli. Future research will need to examine the relationship between anxiety-related bias and drug-related biases in order to confirm this hypothesis. Firstly, the findings of the present thesis could be replicated with some modifications. Specifically a study could be conducted that identifies high trait anxious smokers and low trait anxious smokers and examines possible differences in cognitive and attentional processing of smoking-related stimuli in the two groups. It would also be worthwhile investigating how high and low trait anxiety smokers process both smoking and threat-related material. These types of investigations could extend the understanding of differences between anxiety and smoking-related biases and help the development of theories concerning the etiology of drug-related cognitive and attentional bias.

When considering the self-report measures from studies four, five and six, the card-based Stroop data and the Dot Probe data it is possible to suggest that during a period of deprivation from cigarettes, smokers experience increases in cravings and anxiety, and become preoccupied with smoking-related material. Tiffany (1990) argues that in normal circumstances drug use behaviour is highly automated and effortless. It is only when drug use action schemata are frustrated or drug seeking behaviour is impeded that craving states emerge and more effortfull and controlled drug seeking behaviour is engaged. In this situation the deprived smoker experiences an increase in cognitive activity associated with smoking behaviour and the priming of smoking-related schema. This priming effect then leads to the preferential processing of smoking-related stimuli. The findings from Gross et al. (1993), Johnsen et al. (1997) and Waters and Feyerabend (2000) suggest that there are unconscious processes that operate outside awareness which govern smoking behaviour, and that these are difficult to control. However, the present data may suggest that cognitive and attentional biases towards smoking-related stimuli are not solely determined by automatic and unconscious processing. Analysis of the self-report data in Study Six suggested that when smokers awareness of smoking-related stimuli during task Dot Probe task performance was taken into account a pattern attentional bias for smoking words emerged. Thus, the role of awareness may be an important variable in attentional bias. All smokers whether deprived or not could demonstrate some attentional bias for smoking-related words if the task demands are such that their attention is drawn to smoking-related stimuli. This is especially true in the case of blocked Stroop protocols and the Dot Probe protocols that require vocalisation of the smoking words. The present results suggest that abstinence may not be a necessary or sufficient condition for the emergence of an attentional or cognitive bias for smoking-related stimuli.

9.8 General methodological issues in smoking research

As well as the methodological problems encountered with the use of the Stroop task there were also more general issues that arose from the present research. This section will consider problems associated with conducting abstinence-based research and the ecological validity of the research. Firstly, problems associated with forced abstinence will be discussed. Forced abstinence was a fundamental aspect of the experimental protocol in the present thesis. Although participants who enrolled for experiments were on the whole able to abstain for the required period, there were a number of individuals who on hearing of the abstinence requirements for participation declined their consent. When questioned further they said they would be unable to abstain for six hours. This raises the possibility that those participants who take part in laboratory based experiments involving abstinence may be different from those who decline. Furthermore, it was also observed in the present thesis that a small number of participants were unable to resist smoking during the abstinence period and their data were removed from the analysis. Although non-invasive biochemical measures were used to determine adherence to the abstinence protocol the use of the CO breath test in the present research may not have been sufficient to identify low levels of smoking in the abstinent group of smokers. In order to overcome this problem it would be useful if future research could use more sensitive biochemical indices of smoking such as saliva cotinine (e.g. Waters and Feyerabend (2000).

Now the issue of generalisation in the present research will be considered. It could be argued that the data provided by the present research couldn't be generalised to normal smoking populations. Forced abstinence demands may limit the ecological validity of the findings because smokers who give up for only short periods of time for the purposes of an experiment may not be the same as smokers who elect to quit smoking for good. Only one study to date has studied naturally occurring abstinence and its effects on the processing of smoking-related stimuli (Johnsen et al, 1997). They studied smokers who had enrolled on a smoking cessation course and studied their processing of smoking-related words after three sessions of a six-session programme. They had been abstinent for three days at time of testing. Unfortunately this study did not report any details of the cessation course and the number of participants was small (11) so any generalisation made from this study should be tentative. To address this issue it would be sagacious to conduct more studies of smokers participating in smoking cessation courses and with larger numbers of participants. Furthermore, it would also be useful to conduct studies of naturally occurring abstinence, such as occurs when flying or travelling long distances by coach. The effects of such abstinence on cognitive processing could be studied using a simple portable card-based Stroop. From the present authors personal experience such apparently simple studies are fraught with problems. Pilot research for the present thesis investigated the feasibility of conducting two field studies of naturally occurring abstinence. One study involved long haul bus passengers completing a portable card-based Stroop after a six-hour journey. After one trip it was apparent that even though smoking was banned on the coach smokers ignored warnings and smoked in the chemical toilet, or at the back of the bus making it virtually impossible to obtain abstinence data. A second pilot study examined short haul flight passengers processing of smoking-related words using a portable card-based Stroop. In this study it was found that smokers ignored smoking restrictions in the airport and smoked when waiting for their baggage. The present author had secured access to this area with a view to collecting Stroop data there. Smokers ignoring smoking restrictions therefore frustrated the aims of these two pilot studies. Even though such studies are problematic it may be fruitful to pursue this avenue of research so that more ecologically valid data on the effects of abstinence on processing biases can be obtained. For example, it may be possible to secure access to long haul flights that have strictly enforced smoking restrictions. Studying abstinent smokers in this context would provide interesting data on the processing of smoking-related stimuli.

9.9 Application of the findings to smoking cessation interventions

The findings from the present thesis may have implications for cognitive theories of smoking and smoking cessation interventions. The data from the Card-based Stroop suggests that during acute periods of abstinence smokers' experience a preoccupation with smoking-related stimuli, and that this cognitive bias is automatic and difficult to inhibit. Furthermore, the evidence from the self-report measures in studies four five and six suggests that relatively short periods of abstinence bring about increases in anxiety and cravings for cigarettes. The latter findings have been common knowledge for some time, but empirical findings that short-term abstinence brings about cognitive and attentional biases in the processing of smoking-related information has not been incorporated into smoking cessation interventions. Only one study to date has provided data on the effects of smoking cessation intervention on colour naming of smoking-related words (Johnsen et al., 1997). Although Waters and Feyerabend (2000) do cite a paper presentation by Kassel and Brown (1999) which reported that individual differences in reaction times on neutral items predicted outcome in smoking cessation, and that individual differences in the size of the Stroop effect did not predict outcome. However, such findings have not been replicated and clearly more research is required to determine the effect of different interventions on cognitive bias in smoking. This is important, as there may well be fundamental differences between different interventions and their ability to modify cognitive and attentional bias towards smoking-related stimuli.

Although the Johnsen et al. (1997) study has been criticised for its sampling method, it did suggest that smoking cessation treatment effects smoking word processing. It was found that following three days of 'treatment' abstinent smokers did not show attentional bias for smoking words on a modified Stroop task where active smokers did. It was argued that the lack of attentional bias in abstinent smokers was due to a facilitating treatment effect. As no details were given concerning the nature of the treatment the smokers received it is difficult to evaluate this claim. Given the paucity of research in this area, researchers have advocated that this is an avenue of research that requires further investigation (Gross et al. 1993; Jarvik et al., 1995; Rosenblatt et al., 1996; Johnsen et al., 1997: Waters et al., 2000). However, it would be parsimonious to establish the best and most sensitive measure of treatment effects before any conclusions can be made about attentional biases following interventions.

Furthermore, Gilbert (1995) has argued that treatment interventions for smokers need to be matched to smokers' individual needs and profiles. He argues that the efficacy of approaches would be improved if individual differences in smoking behaviours were taken into account. Therefore, it is possible to argue that certain smokers may be more susceptible to the influence of smoking-related stimuli, and that interventions that focus on the role of such stimuli in smoking maintenance and cessation would be best suited for these types of smokers. For example, a comprehensive smoking cessation intervention called Quit For Life (QFL) has been shown to be effective in rapidly reducing smoking and maintaining smoking cessation (Marks, 1992). The QFL programme is a multifaceted intervention that focuses on reducing smoking by targeting the association between smoking-related stimuli and smoking. The findings of the present thesis would suggest that smokers find smoking-related stimuli distracting under conditions which require them to focus on and cognitively process such stimuli. Therefore, treatment programmes like QFL which focus on the role of smoking-related stimuli in smokers behaviour may modify smokers processing of smoking-related stimuli. Furthermore, the card-based Stroop data from the present thesis suggest that during periods of acute abstinence the smoker is vulnerable to the effects of smoking-related stimuli in the environment and their influence on cognitive functioning is significant at this stage. The pre-occupation with smoking stimuli that the smoker experiences soon after stopping smoking can be disruptive and may frustrate a cessation attempt. It is therefore important that smoking cessation interventions become aware of this fact and incorporates strategies that can deal with this issue. The present thesis has demonstrated that dependence and smoking motivation are factors in smokers' response to abstinence, and that these factors are related to the processing of smoking-related stimuli. Therefore, it may be prudent to determine smokers' level of dependency, anxiety, and smoking motivations prior to commencing cessation as these variables may affect outcome.

9.10 Suggestions for future research

The present research has revealed some inconsistent findings concerning cognitive and attentional bias in smokers' processing of smoking words. There are several avenues of research that could be pursued but the present discussion will be restricted to issues that directly arise from the present thesis. Firstly, a discussion of how the inconsistencies in the present research could be addressed will be presented. This will be followed by a brief discussion of some ideas for further research.

One major issue that any future research would need to address is smoking-related and control words. As has been discussed the present research failed to identify the smoking-relatedness of the control word 'chimney' prior to its use in experiments. As a consequence there was some doubt cast over the findings from the Stroop and Dot Probe data. Prior to conducting more Stroop or Dot Probe research it would be important to generate a more unified set of control words. This could be achieved by having a final panel of smokers rate the smoking-relatedness of both control and smoking-related words. This would provide statistical data on the categorisation of the words. This was not done for the research in the present thesis. As a further check it would also be useful for smokers involved in abstinence studies to rate the extent to which they find the words used in the study to be smoking-related. These data could then be used as a variable in the analysis of smoking-related word processing data.

The present thesis suggests that card-based forms of the Stroop task produce different outcomes in abstinent smokers than single-trial forms of the task, and that these two protocols cannot be assumed to measure the same underlying processes. It would therefore be important to establish the exact nature of the task in smoking and its utility for measuring cognitive bias in the addictions. This could be achieved by using only one Stroop protocol, or by a more systematic evaluation of the effects of using different Stroop protocols and different response modes. Furthermore, it would be useful to examine the relationship between the Stroop task and the Dot Probe task within the same participants to allow for an analysis of cognitive and attentional processing in the same group of participants. This approach was adopted by Mogg, Bradley, Dixon, Fisher, Twelftree and McWilliams (2000) who examined the selective processing of threat in a non-clinical sample of anxious participants. A modified Stroop task and a Dot Probe task were used to study the relationship between the two tasks and to address inconsistencies in the research concerning processing biases in anxiety. The results showed that the two tasks did not produce identical findings. Differences in cognitive bias were indicated by the Stroop task but not by the Dot Probe task. Furthermore, correlation analyses revealed no positive relationship between the bias scores measured by the two tasks, suggesting that the two task index different mechanisms. The Mogg et al. (2000) study therefore provides a clear rational for the use dual tasks to study cognitive and attentional bias in smokers. It is possible to hypothesise that such a study would give rise to findings not dissimilar to the Mogg et al. (2000) study and to the findings of the present thesis.

A further issue arising from the present thesis that is worthy of further investigation is the role of anxiety in smokers processing of smoking-related stimuli. It would be feasible to identify high and low trait anxiety smokers and non-smokers and examine group differences in word processing. Using a Stroop and Dot Probe task the processing of smoking, general threat and control words could be evaluated in order to determine whether the effects of abstinence are specific to smoking stimuli or may also effect the processing of general threat material. As mentioned earlier and discussed by Faunce and Job (2000) there may be fundamental differences between attentional biases in the addictions and biases in anxiety. Studies will need to be conducted that address the question of whether abstinence creates a cognitive bias for all emotion related material or is specific to smoking stimuli.

The previous section discussed the implications of the findings from the present thesis for smoking cessation interventions. It was suggested that there is a need to directly evaluate the effect of cognitive-behavioural smoking cessation interventions on smokers processing of smoking-related stimuli. This could be achieved by a randomised control trail in which smokers are allocated to either a cognitive behavioural intervention, self-help programme or nicotine replacement treatment. Prior to an attempt to quit a smoking-related Stroop and Dot Probe task could be administered to obtain baseline data. Subsequently the same task would be used to evaluate post cessation processing biases at three, six and 12-month follow-ups. This study would be able to evaluate the effect of different cessation interventions on smokers processing of smoking-related stimuli, and to test the hypothesis that a cognitive based intervention (which focuses on the role of smoking-related stimuli in smoking behaviour) would result in a change in the smoking-related processing biases and reduce the prospect of relapse. Further examination of state and trait variables and their relation to bias and the issue of subliminal presentation should be investigated as a great deal of data from the anxiety literature suggests that biases may operate at a pre-conscious level.

Finally, future research should also consider the issue of valence in smoking-related words. It would be fruitful to consider grouping smoking-related words into negative (e.g. cancer, cough, need) and positive valence (e.g. relax, taste) and examine the reactions of smokers to these different valances. Such studies will be able to resolve the issue of relatedness and valence, and determine the relevant contribution of these two important variables in cognitive and attentional bias to addiction-related stimuli. It would also be worth studying biases in addictions using control groups who have as much familiarity with the subject material as smokers. Smoking cessation workers, counsellors etc, could all be used as control groups so the hypothesis that interference in addiction-related Stroop tasks are partly caused by differences in participants familiarity with smoking-related stimuli can be empirically evaluated.

9.11 Conclusion

The research presented in this thesis has examined active and abstinent smokers processing biases for smoking words, and the effects of abstinence on anxiety and self-reported cravings. In general the findings were inconsistent and there were some specific methodological issues that arose from the experimental work. Firstly, the use of the word 'chimney' marred any conclusions drawn from the Stroop and Dot Probe findings. It was argued that future research should adopt a more rigorous method for the development of word lists. Secondly, it was observed that the findings from the Stroop experiments were inconsistent. This may have been due to the type of Stroop protocol used and the mode of response adopted. Various explanations of the effects were explored with the conclusion being that replications of the present work with tighter controls over Stroop protocol will need to be made before more firm conclusion can be made about smokers processing of smoking-related words. However, one conclusion that can be made is that cognitive bias can be demonstrated in abstinent smokers using a card-based format of the Stroop colour-naming task and that attentional bias is dependent on preoccupation and awareness of smoking concepts in a smoking-related Dot Probe task. Therefore, motivational states may be characterised by processing bias, and biases for self-referent material and attentional biases may not solely a function of psychopathology or emotional disorder. However, it is a fact that there are several limitations in the present thesis, which narrow the genralisation of the results. Several suggestions for future researches were offered in the present thesis, with an emphasis on resolving the anomalies in the present research. With the adoption of the specific modifications and replications suggested herein, many of the questions that have been posed by the present research could be addressed and cognitive theories of smoking behaviour hopeful further explored and extended.

References

Abrams, D., Monti, P.M., Carey, K.B., Pinto, R.P., & Jacobus, S.I. (1988). Reactivity to smoking cues and relapse: Two studies of discriminant validity. *Behaviour Research and Therapy,* 26(3), 225-233.

Angst, M. S. (1979). Riskikofaktoren fur starkes zigaretten-rauchen bei jungen Mannern [Risk factors for heavy smoking in young men]. *Journal Suisse de Medecine,* 109, 115-122.

American Psychiatric Association. (1980). *Diagnostic and Statistical Manual of Mental Disorders.* (Vol. 3rd ed). Washington, DC : Author.

American Psychiatric Association. (1994). *Diagnostic and Statistical Manual of Mental Disorders.* (Vol. 4th ed). Washington, DC : Author.

Barker, K., & Robertson, N. (1997). Selective processing and fear of spiders: Use of the Stroop task to assess interference for spider-related, movement and disgust information. *Cognition and Emotion,* 11(3), 331-336.

Bates, T., Mangan, G., Stough, C., & Corballis, P. (1995). Smoking, processing speed and attention in a choice reaction time task. *Psychopharmacology*, 120, 209-212.

Bauer, D., & Cox , M. (1998). Alcohol-related words are distracting to both alcohol and non-abusers in the Stroop colour naming task. *Addiction,* 93(10), 1539-1542.

Bennett, P., & Murphy, S. (1999). *Psychology and Health Promotion.* Buckingham. Open University Press.

Bower, G. (1981). Mood and Memory. *American Psychologist*, 36, 129-148.

Bower, G.H. (1992). How might emotions affect learning? In SA. Christianson (Ed.), *The Handbook of Emotion and Memory* (pp. 3-32). New Jersey: LEA.

Bradley, B., & Mathews,A. (1988). Memory bias in recovered clinical depressives. *Cognition and Emotion,*2(3), *235-245.*

Brandon, T., Tiffany, S.T., Obremski, K.M., & Baker, T.B. (1990). Post cessation cigarette use: The process of relapse. *Addictive Behaviors*, 15, (2), 105-114

Broadbent, D.E. (1958). *Perception and Communication.* London: Pergamon Press.

Broadbent, D., & Broadbent , M. (1988). Anxiety and attentional bias: State and trait. *Cognition and Emotion,* 2(3), 165-183.

Brosschot, J.F., de Ruiter, C., & Kindt, M. (1999). Processing bias in anxious subjects and repressors, measured by emotional Stroop interference and attentional allocation. *Personality and Individual Differences,* 26, 777-793.

Campbell, E., Sanson-Fisher, R., Walh, R. (2001). Smoking status in pregnant women- Assessment of sefl-report against carbon monoxide (CO). *Addictive Behaviours*, 26 (1).

Carmody, T. (1992a). Affect regulation, nicotine addiction and smoking cessation. *Journal of Psychoactive Drugs*, 24(2), 111-122.

Carmody, T. (1992b). Preventing relapse in the treatment of nicotine addiction: Current issues and future directions. *Journal of Psychoactive Drugs,* 24(2), 211-238.

Channon, S., Hemsley, D., & de Silva,P. (1988). Selective processing of food words in Anorexia Nervosa. *British Journal of Clinical Psychology,* 27, 259-260.

Channon, S., & Hayward, A. (1990). The effect of short-term fasting on processing of food cues in normal subjects. *International Journal of Eating Disorders*, 9, 447-452.

Coan, R.W., (1973). Personality variables associated with cigarette smoking. *Journal of Personality and Social Psychology*, 26, 86-104.

Cohen, S., & Lichtenstein, E. (1990). Perceived stress, quitting smoking, and smoking relapse. *Health Psychology,* 9(4), 466-478.

Conney, N.L., Gillespe, R.A., Baker, L.H., & Kaplan, R.F. (1987). Cognitive changes after alcohol cue exposure. *Journal of Consulting and Clinical Psychology*, 55, 150-155.

Cox W.M., Pothos. E.M., & Bauer, D. (2000). More recommendations for the Stroop colour-naming task and addictive behaviours: a reply to Faunce and Soames Job. *Addiction, (Further letters),* 1440-1442.

Dawkins, K., & Furnham, A. (1989). The colour naming of emotional words. *British Journal of Psychology,* 80, 383-389.

Dobbs, S., Strickler, D.P., & Maxwell, W.A. (1981). The effects of stress and relaxation in the presence of stress on urinary PH and smoking behaviors. *Addictive Behaviors*, 6, 345-353.

Droungas, A., Ehrman, R.N., Childress, A.R., & O'Brien, C.P. (1995). Effect of smoking cues and cigarette availability on craving and smoking behavior. *Addictive Behaviors,* 20(5), 657-673.

Drummond, D.C., Tiffany, S.T., Glautier, S., & Remington, B. (Eds.). (1995). *Addictive Behaviour, Cue Exposure Theory and Practice*. Chichester: Wiley and Sons.

Edwards, J.A., Wesnes, K., Warburton, D.M., & Gale, A. (1985). Evidence of more rapid stimulus evaluation following cigarette smoking. *Addictive Behaviors,* 10, 113-126.

Ehlers, A., Margraf, J. Davies, S., & Roth, W.T. (1988). Selective processing of threat cues in subjects with panic attacks. *Cognition and Emotion,* 2(3), 201-219.

England, P. (1996). *A History of Smoking*. (2nd ed.). London: Bracken Books.

Eysenck. (1993). *Cognitive Factors in Generalised Anxiety Disorder.* Paper presented at the European Views In Psychology-Keynote Lectures, Tampere, Finland.

Eysenck, M., Mogg, K., May, J., Richards, A., & Mathews, A. (1991). Bias in interpretation of ambiguous sentences related to threat in anxiety. *Journal of Abnormal Psychology,* 100(2), 144-150.

Eysenck, M., & Byrne, A. (1992b). Anxiety and susceptibility to distraction. *Personality and Individual Differences*, 13(7), 793-798.

Eysenck, M. (1992a). *Anxiety The Cognitive Perspective.* Hove: Lawrence Erlbaum Associates.

Fagerström, K. (1978). Measuring degree of physical dependence to tobacco smoking with reference to individualization of treatment. *Addictive Behaviors,* 3, 235-241.

Fagerström, K. (1989). Treatment of nicotine dependence, *Progress in Brain Research*, 79, 321-326.

Faunce, G.J., & Job, R.F.S. (2000). The Stroop colour-naming task and addictive behaviour: some recommendations. *Addiction*, *(Further letters),* 1438-1439.

Fergusson, D.M., Lynskey, M.T., & Horwood, L.J. (1996). Comorbidity between depressive disorders and nicotine dependence in a cohort of 16-year olds. *General Archives of Psychiatry*, 53, 1043-1047.

Fleming, S., & Lombardo, T.W. (1987). Effects of cigarette smoking on phobic anxiety. *Addictive Behaviors*, 12, 195-198.

Franken, I.H., Kroon, L.Y., & Hendriks, V.M. (2000). Influence of individual differences in craving and obsessive cocaine thoughts on attentional processes in cocaine abuse patients. *Addictive Behaviors*, 25 (1), 99-102.

Fox, E. (1993). Attentional bias in anxiety: Selective or not? *Behaviour Research and Therapy*, 31(5), 487-493.

Gilbert, D.G. (1995). *Smoking: Individual Differences. Psychopathology, and Emotion.* USA: Taylor and Francis.

Gilbert, D.G., & Wesler, R. (1989). Emotion anxiety and smoking. In T. Ney and A. Gale (Eds). *Smoking and Human Behavior* (pp. 171-196). Chichester England: Wiley.

Glautier, S., & Remington, B. (1995). The form of responses to drug cues. In D.C. Drummond, S.T. Tiffany., S. Glautier., B.Remington. (Eds), *Addictive Behaviour: Cue Exposure Theory and Practice* (pp. 21-46). Chichester: John Wiley and Sons.

Glautier, S., & Tiffany, S.T. (1995). Methodological issues in cue reactivity research. In D.C. Drummond, S.T. Tiffany., S. Glautier., B. Remington.(Eds), *Addictive Behaviour: Cue Exposure Theory and Practice* (pp. 75-98). Chichester: John Wiley and Sons.

Gotlib, I., McLachlan, & Katz, A.N. (1988). Biases in visual attention in depressed and non-depressed Individuals. *Cognition and Emotion,* 2(3), 185-200.

Grant, S., London, E.D., Newlin, D.B., Villemagne, V.L., Liu, X., Contoreggi, C., Phillips, R.L., Kimes, A.S., & Margolin, A. (1996). *Activation of memory circuits during cue-elicited cocaine craving.* Paper presented at the National Academy of Sciences.

Greely, J., Ryan, C.. (1995). The role of introceptive cues for drug delivery in conditioning models of drug dependence. In DC. Drummond, ST. Tiffany., S. Glautier., & B. Remington (Eds), *Addictive Behaviour: Cue Exposure Theory and Practice* (pp. 119-136). Chichester: John Wiley and Sons.

Gross, T., Jarvik, M.E., & Rosenblatt, M.R. (1993). Nicotine abstinence produces content-specific Stroop interference. *Psychopharmacology,* 110, 333-336.

Gunn, R. C. (1983). Smoking clinic failures and recent life stress. *Addictive Behaviors, 8,* 83-87.

Hatsukami, D., Skoog, K., Huber, M., & Hughes, J. (1991). Signs and symptoms from nicotine gum abstinence. *Psychopharmacology*, 104, 496-504.

Hepple, J., & Robson, P. (1996). The effect of caffeine on cue exposure responses in ex-smokers. *Addiction*, 91(2), 269-273.

Holle, C., Neely, J.H., & Heimberg, R.G. (1997). The effects of blocked versus random presentation and semantic relatedness of stimulus words on responses to a modified Stroop task. *Cognitive Therapy and Research,* 21, 681-697.

Horn, D., & Waingrow, S. (1966). Questionnaire. *Behaviour and Attitudes* (April).

Hughes, J.R., & Hatsukami, D.K. (1986). Signs and symptoms of tobacco withdrawal. *Archives of General Psychiatry,* 43, 289-294.

Hughes, J.R., Hatsukami, D.K., Mitchell, J.E., & Dahlgren, L.A. (1986). Prevalence of smoking among psychiatric outpatients. *American Journal of Psychiatry*, 143, 993-997.

Hunt, W. A. (Ed.). (1970). *Learning Mechanisms in Smoking* (1 ed.). Chicago: Aldine Publishing Company.

Ikard, F.F., Green, D.E., & Horn, D. (1969). A scale to differentiate between types of smoking as related to the management of affect. *The International Journal of the addictions, 4*(4), 649-659.

Ikard, F. F., & Tomkins, S. (1973). The experience of affect as a determinant of smoking behavior: A series of validity studies. *Journal of Abnormal Psychology,* 81, 172-181.

Irving, J. M., Clark, E.C., Crombie, I.K., & Smith. W.S. (1988). Evaluation of a portable measure of expired-air carbon monoxide. *Preventive Medicine*, 17, 109-115.

Jarvik, M., Gross, T.M., Rosenblatt, M.R., & Stein, RE. (1995). Enhanced lexical processing of smoking stimuli during smoking abstinence. *Psychopharmacology*, 118, 136-141.

Jarvik, M. E. (1973). Further observations on nicotine as the reinforcing agent in smoking. In W. L. Dunn (Ed.), *Smoking Behaviour : Motives and Incentives* (pp. 33-49). Washington DC: V.H. Winston.

Jarvis, M.J., Russell, M.A.H., & Saloojee, Y.(1980). Expired air carbon monoxide: a simple breath test of tobacco smoke intake. *British Medical Journal*, 281, 484-485.

Johnsen, B. H., Laberg, J.C., Cox, W.M., Vaksdal, A., & Hugdahl, K. (1994). Alcohol abusers' attentional bias in the processing of alcohol-related words. *Psychology of Addictive Behaviors,* 8, 111-115.

Johnsen, B. H., Thayer, J.F., Laberg, J.C., & Asbjornsen, A.E. (1997). Attentional bias in active smokers, abstinent smokers, and non-smokers. *Addictive Behaviors,* 22(6), 813-817.

Kaplan, R., Cooney, N.L., Baker, L.H., Gillespe, R.A., Meyer, R.E., & Pomerleau, O.F. (1985). Reactivity to alcohol-related cues: Physiological and subjective responses in alcoholics and non-problem drinkers. *Journal of Studies on Alcohol,* 46(4), 267-272.

Kassel, J. D., & Shiffman, S. (1997). Attentional mediation of cigarette smoking's effect on anxiety. *Health Psychology*, 16(4), 359-368.

Killen, J., Fortmann, S.P., Kraemer, H.C., Varady, A., & Newman, B. (1992). Who will relapse? Symptoms of nicotine dependence predict long-term relapse after smoking cessation. *Journal of Consulting and Clinical Psychology*, 60(5), 797-801.

Kindt, M., Bierman, D., & Brosschot, J.F. (1996). Stroop versus Stroop; Comparison of a card format and a single-trial format of the standard colour-word Stroop task and the emotional Stroop task. *Personality and Individual Differences,* 21(5), 653-661.

Klorman, R., Weerts, J.E., Melamed, G.B.G., & Lang, P.J. (1974). Psychometric description of some specific fear questionnaires. *Behavior Therapy,* 5, 401-409.

Klitzke, M., Irwin, R., Lombardo, T.W & Christoff, K.A. (1990). Self-monitored smoking motives. Joournal of substance abuse, 2, 121-127.

Kozlowski, L. T.,& Herling, S. (1988). Objective Measures. In D.M. Donovan., & G.A. Marlatt. (Eds), *Assessment of Addictive Behaviours* (pp. 214-238). London: Hutchinson.

Kozlowski, L. T., Jarvik, M.E., & Gritz, E.R. (1975). Nicotine regulation and cigarettes smoking. *Clinical Pharmacology and Therapeutics,* 17(1), 93-97.

Kroeze, S., & van den Hout, M.A. (2000). Selective attention for cardiac information on panic patients. *Behaviour Research and Therapy,* 38(1), 63-72.

Kumar, R., Cooke, E.C., Lader, M.H., & Russell, M.A.H. (1977). Is nicotine important in tobacco smoking? *Clinical Pharmacology and Therapeutics,* 21(5), 520-529.

Lando, H., McGovern, P.G., Kelder, S.H., Jeffery, R.W., & Forster, J.L. (1991). Use of carbon monoxide breath validation in assessing exposure to cigarette smoke in a worksite population. *Health Psychology,* 10(4), 296-301.

Lavy, E. H.,& van den Hout, M.A. (1993). Attentional bias for appetitive cues: Effects of fasting in normal subjects. *Behavioral and Cognitive Psychotherapy*, 21, 297-310.

Lavy, E.H. van den Hout, M. & van dern Arntz.(1993). Attentional bias and spider phobia: Conceptual and clinical issues. *Behaviour Research and Therapy,* 31, 17-24.

Le Houezec, J., Halliday, R., Benowitz, N.L., Callaway, E., Naylor, H., & Herzig, K. (1994). A low dose of subcutaneous nicotine improves information processing in non-smokers. *Psychopharmacology,* 114, 628-634.

Leventhal, H., & Cleary, P.D. (1980). The smoking problem: A review of the research and theory in behavioral risk modification. *Psychological Bulletin*, 88(2), 370-405.

Levin, E., Rose, J.E., Behm,F., & Caskey, N.H. (1991). The effects of smoking-related sensory cues on psychological stress. *Pharmacology Biochemistry and Behavior*, 39, 265-268.

Litz, B., Payne, T.J., & Colletti, G. (1987). Schematic processing of smoking information by smokers and never-smokers. *Cognitive Therapy and Research,* 11(3), 301-313.

Lucchessi, B. R., Schuster, C.R., & Emley, G.S. (1967). The role of nicotine as determinant of cigarette smoking in man with observation of certain cardiovascular effects associated with tobacco alkaloid. *Clinical Pharmacology and Therapeutics*, 8(6), 789-796.

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology*, 95(1), 15-20.

MacLeod, C., Tata, P., & Mathews, A. (1987). Perception of emotionally valenced information in depression. *British Journal of Clinical Psychology,* 26, 67-68.

MacLeod, C., & Mathews, A. (1988). Anxiety and the allocation of attention to threat. *The Quarterly Journal of Experimental Psychology*, 40(4), 653-670.

MacLeod, C., & Mathews, A. (1991). Biased cognitive operations in anxiety: Accessibility of information or assignment of processing priorities ? *Behaviour Research and Therapy,* 29(6), 599-610.

MacLeod, C. (1991). Half a century of research on the Stroop effect: An integrative review. *Psychological Bulletin,* 109, 163-203.

MacLeod, C., & Rutherford, E.M. (1992). Anxiety and the selective processing of emotional information: Mediating roles of awareness, trait and state variables, and personal relevance of stimulus materials. *Behaviour Research and Therapy,* 30(5), 479-491.

Marks, D.M. (1992). Smoking cessation as a testbed for psychological theory: A group cognitive therapy programme with long term abstinence rates. *Journal of Smoking Related Diseases*, 3(1), 69-77.

Marlatt, G.A. (1979). A cognitive-behavioural model of the relapse process. In: Behavioural Analysis and Treatment of Substance Abuse. N.A. Krasnegor (Ed.). NIDA research Monograph, (25), 191-201. National Institute on Drug Abuse: U.S. Government Printing Office.

Marlatt, G.A. (1985). Cognitive factors in the relapse process. In G. A. Marlatt & J. R. Gordon (Eds.), *Relapse Prevention* (pp. 128-200). New York: Guildford Press.

Marlatt, G.A., Curry, S., & Gordon, J.R. (1988). A longitudinal analysis of unaided smoking cessation. *Journal of Consulting and Clinical Psychology*, 56, 715-720.

Martin, M., Williams, R.M., & Clark, D.M. (1991). Does anxiety lead to selective processing of threat-related information? *Behaviour Research and Therapy, 29*(2), 147-160.

Mathews, A., & MacLeod, C. (1985). Selective processing of threat cues in anxiety states. *Behaviour Research and Therapy*, 23(5), 563-569.

Mathews, A., May, J., Mogg, K., & Eysenck, M. (1990). Attentional bias in anxiety: selective search or defective filtering? *Journal of Abnormal Psychology,* 99(2), 166-173.

Mathews, A., & Klug, F. (1993). Emotionality and interference with colour-naming in anxiety. *Behaviour Research and Therapy,* 57-62(31), 57-62.

Mattia, J., Heimberg, R.G., & Hope, D.A. (1993). The revised Stroop colour-naming task in social phobics. *Behavior Research and Therapy*, 31(3), 305-313.

Maude-Griffin, P. M., & Tiffany, S. (1996). Production of smoking urges through imagery: The impact of affect and smoking abstinence. *Experimental and Clinical Psychopharmacology*, 4(2), 198-208.

McCusker, C.G. (2001). Cognitive biases and addiction: an evolution in theory and method. *Addiction*, 96, 47-56.

McCusker, C.G., & Gettings, B. (1997). Automaticity of cognitive biases in addictive bheaviours: further evidence with gamblers. *British Journal of Clinical Psychology*, 36, 542-554.

McKennell, A.C. (1970). Smoking motivation Factors. *British Journal of Social and Clinical Psychology*, 9, 8-22.

McNally, R., Reiman, B.C., & Kim, E. (1990). Selective processing of threat cues in panic disorder. *Behaviour Research and Therapy*, 28(5), 407-412.

McNally, R., Kaspi, S.P., Rieman, B.C., & Zeitlin, S.B. (1990). Selective processing of threat cues in posttraumatic stress disorder. *Journal of Abnormal Psychology*, 99, 398-402.

McNally, R., Rieman, B.C., Louro, CE., Lukach, B.M., & Kim, E. (1992). Cognitive processing of emotional information in panic disorder. *Behaviour Research and Therapy,* 30(2), 143-149.

Mogg, K., Mathews, A., & Weinman, J. (1989). Selective processing of threat cues in anxiety states: A replication. *Behaviour Research and Therapy*, 27(4), 317-323.

Mogg, K., Mathews, A.M., Bird, C., & McGregor-Moris, R. (1990). Effects of stress and anxiety on the processing of threat stimuli. *Journal of Personality and Social Psychology,* 59, 1230-1237.

Mogg, K., Bradley, B.P., & Hallowell, N. (1994). Attentional bias to threat: Roles of trait anxiety, stressful events, and awareness. *Journal of Experimental Psychology*, 47a(4), 841-864.

Mogg, K., Bradley, B.P., & Williams, R. (1995). Attentional bias in anxiety and depression: The role of awareness. *British Journal of Clinical Psychology,* 34, 17-36.

Mogg, K., & Bradley, B.P. (1998a). A cognitive-motivational analysis of anxiety. *Behaviour Research and Therapy,* 36, 809-848.

Mogg, K., Bradley, B.P., Hyare, H., & Lee, S. (1998b). Selective attention to food-related stimuli on hunger: Are attentional biases specific to emotional and psychopathological states, or are they also found in normal drive states? *Behaviour Research and Therapy,* 36, 227-237.

Mogg, K., Bradley, B.P., Dixon, C., Fisher, S., Twelftree, H., & McWilliams, A. (2000). Trait anxiety, defensiveness and selective processing of threat: An investigation using two measures of attentional bias. *Personality and Individual Differences*, 28, 1063-1077.

Nesbitt, P. D. (1973). Smoking, physiological arousal, and emotional response. *Journal of Personality and Social Psychology*, 25, 137-144.

Ney, T., & Gale, A. (Eds.). (1989). *Smoking and Human Behavior*. London: John Wiley and Sons Ltd.

Niaura, R., Abrams, D., Demuth, B., Pinto, R., & Monti, P. (1989). Responses to smoking-related stimuli and early relapse to smoking. *Addictive Behaviors,* 14, 419-428.

Niaura, R., Abrams, D.B., Pedraza, M., Monti, P.M., & Rohsenhow, D.J. (1992). Smokers reactions to interpersonal interaction and presentation of smoking cues. *Addictive Behaviors,* 17, 557- 566.

O'Connell, K., & Martin, E.J. (1987). Highly tempting situations associated with abstinence, temporary lapse, and relapse among participants in smoking cessation programs. *Journal of Consulting and Clinical Psychology*, 55(3), 367-371.

Office of National Statistics (1997). *Living in Britain: Preliminary results from the 1996 General Household Survey* . London: The Stationery Office.

Office of National Statistics (1998). *Report of the Scientific Committee on Tobacco and Health* . London: The Stationary Office.

O'Neill, S.T., & Parrott, A.C. (1992). Stress and arousal in sedative and stimulant cigarette smokers. *Psychopharmacology*. 107, 442-440.

O'Rorke, P., & Ortony, A. (1994). Explaining Emotions. *Cognitive Science,* 18, 283-323.

Ortony, A., & Turner, T.J. (1990). What's basic about basic emotions? *Psychological Review*, 97(3), 315-331.

Ortony, A., & Clore, G.L., & Collins, A. (1994). *The Cognitive Structure of Emotions*. Cambridge: Cambridge University Press.

Parrott, A.C. (1993). Cigarette smoking effects upon self-rated stress and arousal over the day. *Addictive Behaviors*, 18, 389-396.

Parrott, A.C. (1994a). Individual differences in stress and arousal during cigarette smoking. *Psychopharmacology*, 115, 389-396.

Parrott, A.C. (1994b). Acute pharmacodynamic tolerance to the subjective effects of cigarette smoking. *Psychopharmacology,* 116, 93-97.

Parrott, A.C. (1994c). Does cigarette smoking increase stress. *Addiction*, 89, 142-144.

Parrott, A.C. (1995). Stress modulation over the day in cigarette smokers. *Addiction*, 90, 233-244.

Parrott, A.C., & Joyce, C. (1993). Stress and arousal rhythms in cigarette smokers, deprived smokers and non-smokers. *Human Psychopharmacology*, 8, 21-28.

Patton, D., Barnes, G.E., & Murray, R.P. (1993). Personality characteristics of smokers and ex-smokers. *Personality and Individual Differences,* 15(6), 653-664.

Payne, T., Schare, M.L., Levis, D.J., & Colletti, G. (1991). Exposure to smoking-relevant cues: effects on desire to smoke and topographical components of smoking behavior. *Addictive Behaviors*, 16, 467-479.

Payne, T., Smith, P.O., Sturges, L.V., & Holleran, S.A. (1996). Reactivity to smoking cues: mediating roles of nicotine dependence and duration of deprivation. *Addictive Behaviors,* 21(2), 139-154.

Peele, S. (1985). *The Meaning of Addiction: Compulsive Experience and its Interpretation.* (Vol. 1). Massachusette/Tortonto: Lexington Books.

Peele, S. (1998). *The Meaning of Addiction: An Unconventional View.* San Francisco: Jossey-Bass.

Pianezza, M. L., Sellers, E.M., & Tyndale, R.F. (1998). Nicotine metabolism defect reduces smoking. *Nature*, 393(25 June), 750.

Pomerleau, O., Adkins, D., & Pertschuk M. (1978). Predictors of outcome and recidivism in smoking cessation treatment. *Addictive Behaviors*, 3, 65-70.

Pomerleau, O., & Pomerleau, C.S. (1988). A biobehavioural view of substance abuse and addiction. In S. Peele (Ed.), *Visions of Addiction: Major Contemporary Perspectives on Addiction and Alcoholism* (pp. 117-140). New York: Lexington Books.

Pomerleau, O., & Pomerleau, C.S. (1989). A biobehavioral perspective on smoking. In T. Net & A.Gale (Eds.), *Smoking and Human Behavior* (pp. 69-90). Chichester: Wiley.

Pomerleau, O., & Pomerleau, C.S. (1991). Research on stress and smoking: progress and problems. *British Journal of Addiction*, 86 (5), 599-603.

Pomerleau, O. F., Turk, D.C., & Fertig, J.B. (1984). The effects of cigarette smoking on pain and anxiety. *Addictive Behaviors*, 9, 265-271.

Pomerleau, O. F., & Pomerleau, C.S. (1984). Neuroregulators and the reinforcement of smoking: towards a biobehavioral explanation. *Neuroscience and Biobehavioral Reviews,* 8, 503-513.

Powell, J., & Gray, J. (1993). Subjective craving for opiates: Evaluation of a cue exposure protocol for use with detoxified opiate addicts. *British Journal of Clinical Psychology*, 32 (1), 39-53.

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

Quinlan, P. (1992). The Oxford Psycholinguistic Database (Version 1). Oxford: Oxford University Press.

Rose, J., & Behm, F.M. (1987). Refined cigarette smoke as a means to reduce nicotine intake. *Pharmacology Biochemistry and Behaviour,* 28, 305-310.

Rosenblatt, M. R., Jarvik, M.E. Olmstead, R.E., & Iwamoto-Schaap, P.N. (1996). Memory for cigarette advertisements enhanced by smoking abstinence. *Experimental and Clinical Psychopharmacology,* 4(4), 447-450.

Russell, M. A. H., Peto, J., & Patel, V.A. (1974). The classification of smoking by a factorial structure of motives. *Journal of the Royal Statistical Society*, 137, 313-346.

Ruiter, C., & Brosschot, J.F. (1994). The emotional Stroop interference effect in anxiety: Attentional bias or cognitive avoidance? Behaviour Research and Therapy, 32, 315-319.

Salin-Pascual, R. J., Rosas, M., & Jimenez-Genchi. (1996). Antidepressant effect of transdermal nicotine patches in non-smoking patients with major depression. *Journal of Clinical Psychiatry,* 57, 387-389.

Sayette, M. A., & Hufford, M.R. (1994). Effects of cue exposure and deprivation on cognitive resourses in smokers. *Journal of Abnormal Psychology,* 103(4), 812-818.

Schachter, S. (1977). Nicotine regulation in heavy and light smokers. *Journal of Experimental Psychology: General*, 106, 13-19.

Schachter, S. (1978). Pharmacological and psychological determinants of smoking. *Annals of Internal Medicine*, 88, 104-114.

Schneider, N. G., & Houston, J.P. (1970). Smoking and anxiety. *Psychological Reports,* 26, 941-942.

Schneider, W., Dumais, S.T., & Shiffrin, R.M. (1984). Automatic and control processing and attention. In R. Parasuraman & D.R. Davies (Eds.), *Varieties of attention.* New York: Academic Press.

Schwarzer, R., & Fuchs, R. (2001). Self-efficacy and Health Behaviours. In: Conner, M., & Norman, P., (eds). *Predicting Health Behaviour.* Buckingham: Open University Press, 163-196.

Setter, F., Ackermann, K., Bizer, A., Straube, E.R., & Mann, K. (1995). Effects of disease-related cues in alcohol abusers inpatients:results of a controlled "alcohol Stroop" study. *Alcoholism Clinical and Experimental Research,* 19, 593-599.

Sharma, D., & McKenna, F.P. (1998). Differential components of the manual and vocal Stroop tasks. *Memory and Cognition*, 26(5), 1033-1040.

Shiffman, S. (1982). Relapse following smoking cessation: A situational analysis. *Journal of Consulting and Clinical Psychology*, 50, 71-86.

Shiffman, S. (1986). A cluster analytic classification of smoking relapse episodes. *Addictive Behaviors, 11*, 295-307.

Shiffman, S. (1989). Trans-situational consistency in smoking relapse. Health Psychology, 8(4), 471-481.

Shiffman, S., Fischer, L.B., Zettler-Segal, M., & Benowitz, N.L. (1990). Nicotine exposure among dependent and non-dependent smokers. *Archives of General Psychiatry*, 47, 333-336.

Shiffman, S., & Prange, M. (1988). Self-reported and self-monitored smoking patterns. *Addictive Behaviors*, 13, 201-204.

Siegel, S. (1975). Evidence from rats that morphine tolerance is a learned response. *Journal of Comparative and Physiological Psychology*, 89, 498-506.

Siegel, S. (1989). Pharmacological conditioning and drug effects. In A.J. Goudie. &. M.W. Emmett-Oglesby (Eds), *Psychoactive Drugs: Tolerance and Sensitisation* (pp. 115-180). Clifton,NJ: Humana Press.

Sillett, R. W., Wilson, M.B., Malcolm, R.E., & Ball, K.P. (1978). Deception among smokers. *British Medical Journal*, 2, 1185-1186.

Solomon, R., & Corbit, J. (1973). An opponent-process theory of motivation: Cigarette addiction. *Journal of Abnormal Psychology*, 81, 158-171.

Solomon, R. L., & Corbit, J.D. (1974). An opponent -process theory of motivation: I. Temporal dynamics of affect. *Psychological Review*, 81, 119-145.

Solomon, R. L. (1978). The opponent-process theory of acquired motivation: The costs of pleasure and the benefits of pain. *American Psychologist*, 35, 691-712.

Spielberger, C.D., Gorush, R.L., Lushene, R.E. Vagg, P.R., Jacobs, G.A. (1983). The State-Trait Anxiety Inventory (Test Manual). *Consulting Psychologist Press.*

Spielberger, C. D., & Jacobs, G.A. (1982). Personality and smoking behaviour. *Journal of Personality Assessment*, 46, 396-403.

Spielberger, C. D. (1986). Psychological determinants of smoking behavior. In R. D. Tollinson (Ed.), *Smoking and Society: Toward a more balanced assessment* (pp. 89-134). Lexington: Heath.

Stirling, N. (1979). Stroop Interference: An input and output phenomenon. *Journal of Experimental Psychology*, 31, 121-132.

Stacy, A.W. (1997). Memory activation and expectancy as prospective predictors of lcohol and marijuana use. *Journal of Abnormal Psychology*, 106, 561-574.

Stanton, W.R., Mahalski, P.A., McGee, R., & Silva, P.A. (1993). Reasons for smoking or not smoking in early adolescence. *Addictive Behaviors*, 18, 321-329.

Stolerman, I. P., Goldfarb, T., Fink, R., & Jarvik, M.E. (1973). Influencing cigarette smoking with nicotine antagonists. *Psychopharmacologia*, 28, 247-259.

Strongman, K. T. (1996). *The Psychology of Emotion: Theories of emotion in perspective.* (4th ed.). Chichester: Wiley and Sons.

Stroop, J. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 18, 643-661.

Suter, W., & Battig, K. (1973). Vegetative affects of Stroop-Test solving cigarette smoking. *Swiss Federal Institute of Technology.*

Tate, J.C., & Stanton, A,L. (1990). Assessment of the validity of the reasons for smoking scale. Addictive behaviors, 15, 129-135.

Tiffany, S., & Hakenewerth, D.M. (1991). The production of smoking urges through an imagery manipulation: psychophysiological and verbal manifestations. *Addictive Behaviours*, 16, 389-400.

Tiffany, S. T. (1990). A Cognitive model of drug urges and drug-use behaviour: Role of automatic and non-automatic processes. *Psychological review*, 97(2), 147-168.

Tiffany, S. T., & Drobes, D.J. (1991). The development and initial validation of a questionnaire on smoking urges. *British Journal of Addiction*, 86, 1467-1476.

Tiffany, S. T. (1995a). Potential functions of classical conditioning in drug addiction. In D. C. Drummond, Tiffany, S.T., Glautier, S.,& Remington,B. (Ed.), *Addictive Behaviour Cue Exposure Theory and Practice* (pp. 47-71). New York: John Wiley and Sons.

Tiffany, S. T. (1995b). The role of cognitive factors in reactivity to drug cues. In D. C. Drummond, Tiffany, S.T., Glautier, S., & Remington, B. (Eds.), *Addictive Behaviour Cue Exposure Theory and Practice* (pp. 137-165). New York: John Wiley and Sons.

Tomkins, S. S. (1966). Psychological Model of Smoking Behaviour. *American Journal of Public Health,* 56(suppl.), 17-20.

Tomkins, S. S. (1968). A modified model of Smoking Behaviour. In EF. Borgatta, & Evans.R. (Eds.), *Smoking Health and Behaviour* (pp. 165-186). Chicago: Aldine.

Tools, P. S. (1990). MEL: Micro Experimental Lab (Version 1.0). Pittsburgh: Psychology Software Tools.

U.S. Public Health Service. (1964). *Smoking and health: report of the advisory Committee to the Surgeon General of the Public Health Service* (PHS Publication No. 1103). U.S.

Department of Health Education and Welfare, Publics Health Service, Centers for Disease Control.Washington, DC: U.S. Government Printing Office.

Valentine, E. R. (1992). *Conceptual issues in psychology*. (2nd ed.). London: Routledge.

Warburton, D. M., & Walters, A.C. (1989). Attentional Processing. In T.Ney & A.Gale (Eds), *Smoking and Human Behavior* (pp. 223-238): Wiley and Sons Ltd.

Waters, A. J., & Feyerabend, C. (2000). Determinants and effects of attentional bias in smokers. *Psychology of Addictive Behaviors, 14*(2), 111-120.

Watts, F., McKenna, F.P., Sharrock, R., & Trezise, L. (1986). Colour naming of phobia-related words. *British Journal of Psychology*, 77, 97-108.

Watts, F., Trezise, T., & Sharrock, R. (1986). Processing of phobic Stimuli. *British Journal of Clinical Psychology*, 25, 253-259.

Wells, A., Mathews, G. (1994). *Attention and Emotion*. Lawrence Erlbaum, UK: Hove .

Wesnes, K., & Warburton, D.M. (1978). The effects of smoking and nicotine tablets upon human attention. In R. E. Thornton (Ed.), *Smoking Behaviour: Physiological and Psychological Influences* (pp. 131-147). London: Churchill Livingston.

Wesnes, K., & Warburton, D.M. (1983). Smoking, nicotine and human performance. *Pharmacology and Therapeutics*, 21, 189-208.

Wesnes, K., & Revell, A. (1984). The separate and combined effects of scopolamine and nicotine on human information processing. *Psychopharmacology*, 84, 5-11.

West, R. J., & Russell, M.A.H. (1985). Pre-abstinence smoke intake and smoking motivation as predictors of severity of cigarette withdrawal symptoms. *Psychopharmacology*, 87, 334-336.

Wikler, A. (1973). Conditioning of successive adaptive responses to the initial effects of drugs. *Conditioned Reflex*, 8, 193-210.

Wikler, A. (1984). Recent progress in research on the neurophysiologic basis of morphine addiction. *Americal Journal of Psychiatry*, 105, 329-338.

Williams, J., & Broadbent,K. (1986). Distraction by emotional stimuli: Use of a Stroop task with suicide attempters. *British Journal of Clinical Psychology*, 25,*101-110.*

Williams, J. M. G., Mathews, A., & MacLeod, C. (1996). The emotional Stroop task and psychopathology. *Psychological Bulletin*, 120(1), 3-24.

Williams, M., Watts, G., MacLeod, F.N., & Mathews, A. (1988). *Cognitive Psychology and Emotional Disorders*: Chichester:Wiley.

Williams, M., Watts, F.N., MacLeod, C., & Mathews, A (1990). An information processing analysis of the emotional disorders. A review of cognitive psychology and emotional disorders. *Cognition and Emotion*, 4(1), 52-60.

Yates, F. A. (1966). *The art of memory*. London: Routledge & Regan Paul.

Zwaan, R.A.,& Truitt, T.P. (1988). Smoking urges affect language processing. Experimental and Clinical *Psychopharmacology*, (6) 3, 325-330.

Appendices

Appendix 4.1

Smoking-related Words Questionnaire

This study is concerned with words that are related to smoking. Please lists as many words as you can that you think are related to smoking.

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Appendix 4.2

Table 4.2: List of first phase smoking-related words

Word / Phrase
Addict
Addiction
Adverstisments
Amputation
Annoyance
Anxiety
Arteriosclerosis
Ash
Ashtray
BandH
Bad
Bad air
Bad breath
Bar
Beer
Breathing
Bronchitis
Butt
Camel
Cancer
Cigar
Cigarette
Coffee
Company
Cough
Coughing
Craving
Death
Dinner
Dizzy
Drag
Drink
Drinking
Drinks
Dunhill
Eating
Evening
Fags
Filtered
Friends
Guilt
Habit
Health
High-tar
Inhale
Invade
Joint
Joints
Leisure
Light
Lighter
Longing
Low-tar
Lung cancer
Lungs
Matches
Money
Need
Nicotine
Outcast
Outside
Papers
Party
Passive smoking
Pipe
Pub
Puff
Pull
Relax
Relaxation
Rollies
Shake
Silk cut
Smell
Smelly
Smoke
Smokey
Social
Social image
Sore throat
Stained fingers
Stink
Stress
Tar
Taste
Third world
Tobacco
Tolerance
Trembling
Wheezing
Winter
Yellow

Appendix 4.3

Smoking-related Words Questionnaire

Please study the list of words below and rate them according to whether you think each word is related to smoking. Don't think about each word for too long, work as quickly as possible.

ashtray	Very unrelated	1	2	3	4	5	6	Very related
cancer	Very unrelated	1	2	3	4	5	6	Very related
smell	Very unrelated	1	2	3	4	5	6	Very related
ash	Very unrelated	1	2	3	4	5	6	Very related
cough	Very unrelated	1	2	3	4	5	6	Very related
smoke	Very unrelated	1	2	3	4	5	6	Very related
tobacco	Very unrelated	1	2	3	4	5	6	Very related
addiction	Very unrelated	1	2	3	4	5	6	Very related
drag	Very unrelated	1	2	3	4	5	6	Very related
fags	Very unrelated	1	2	3	4	5	6	Very related
cigarette	Very unrelated	1	2	3	4	5	6	Very related
lighter	Very unrelated	1	2	3	4	5	6	Very related
matches	Very unrelated	1	2	3	4	5	6	Very related
coffee	Very unrelated	1	2	3	4	5	6	Very related
bar	Very unrelated	1	2	3	4	5	6	Very related
puff	Very unrelated	1	2	3	4	5	6	Very related
habit	Very unrelated	1	2	3	4	5	6	Very related
yellow	Very unrelated	1	2	3	4	5	6	Very related
tar	Very unrelated	1	2	3	4	5	6	Very related
guilt	Very unrelated	1	2	3	4	5	6	Very related
death	Very unrelated	1	2	3	4	5	6	Very related
inhale	Very unrelated	1	2	3	4	5	6	Very related
relax	Very unrelated	1	2	3	4	5	6	Very related
need	Very unrelated	1	2	3	4	5	6	Very related
butt	Very unrelated	1	2	3	4	5	6	Very related
light	Very unrelated	1	2	3	4	5	6	Very related
dizzy	Very unrelated	1	2	3	4	5	6	Very related
bad	Very unrelated							Very related

		1	2	3	4	5	6	
drinking	Very unrelated							Very related
		1	2	3	4	5	6	
invade	Very unrelated							Very related
		1	2	3	4	5	6	
bronchitis	Very unrelated							Very related
		1	2	3	4	5	6	
addict	Very unrelated							Very related
		1	2	3	4	5	6	
illness	Very unrelated							Very related
		1	2	3	4	5	6	
social	Very unrelated							Very related
		1	2	3	4	5	6	
stress	Very unrelated							Very related
		1	2	3	4	5	6	
eating	Very unrelated							Very related
		1	2	3	4	5	6	
anxiety	Very unrelated							Very related
		1	2	3	4	5	6	
shake	Very unrelated							Very related
		1	2	3	4	5	6	

Appendix 4.4

Smoking Motivation Questionnaire

(27 items, 8 sub-scales version)

Name Date Daily cigarette consumption

Age Sex

How long have you smoked?

Please indicate how much each of the following statements apply to your reasons for smoking. Please draw a circle around the appropriate number.

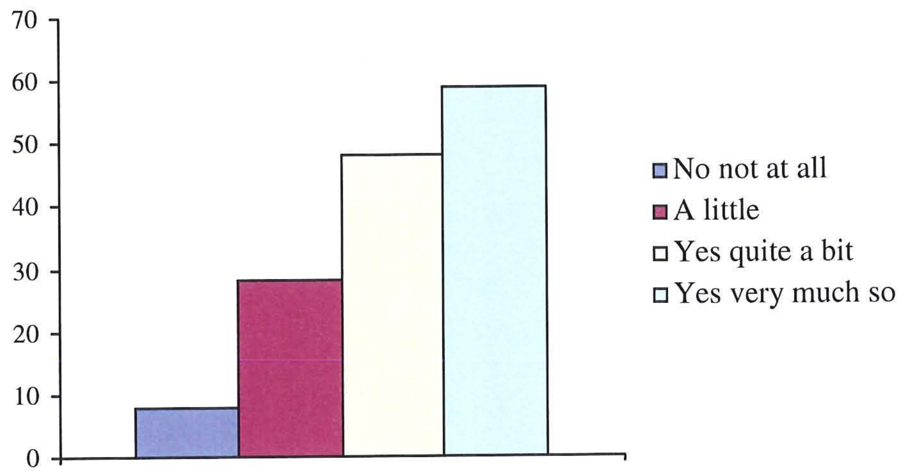
NO NOT AT ALL	A LITTLE	YES QUITE A BIT	YES VERY MUCH
0	1	2	3

1	I get a definite craving for a cigarette when I haven't had one for a while	0	1	2	3
2	I light up a cigarette without realising that I still have one burning in the ashtray	0	1	2	3
3	I like a cigarette best when I am having a quite rest	0	1	2	3
4	I get a definite pleasure whenever I smoke	0	1	2	3
5	Handling a cigarette is part of the enjoyment of smoking it	0	1	2	3
6	I think I look good with a cigarette	0	1	2	3
7	I smoke when I am worried about something	0	1	2	3
8	I smoke according to a regular routine	0	1	2	3
9	I get a definite lift and feel more alert when smoking	0	1	2	3
10	I smoke automatically without even being aware of it	0	1	2	3
11	I smoke to have something in my hands	0	1	2	3
12	When I have run out of cigarettes I find it almost unbearable until I can get some more	0	1	2	3
13	I smoke at certain times of the day	0	1	2	3
14	I smoke more when I am unhappy	0	1	2	3
15	Smoking helps to keep me going when I am tired	0	1	2	3
16	I find it difficult to go as long as an hour without smoking	0	1	2	3
17	I find myself smoking without remembering lighting up	0	1	2	3
18	I want to smoke most when I am comfortable and relaxed	0	1	2	3
19	Smoking helps me to think and concentrate	0	1	2	3
20	I get a real gnawing hunger to smoke when I haven't smoked for a while	0	1	2	3
21	I have developed a regular pattern of smoking	0	1	2	3
22	I feel I look more mature and sophisticated when smoking	0	1	2	3
23	I am very much aware of the fact when I am not smoking	0	1	2	3
24	I would find it difficult to go without smoking for as long as a week	0	1	2	3
25	I smoke to have something to put in my mouth	0	1	2	3
26	I feel more attractive to the opposite sex when smoking	0	1	2	3
27	I smoke more when I feel angry about something	0	1	2	3

Appendix 4.5

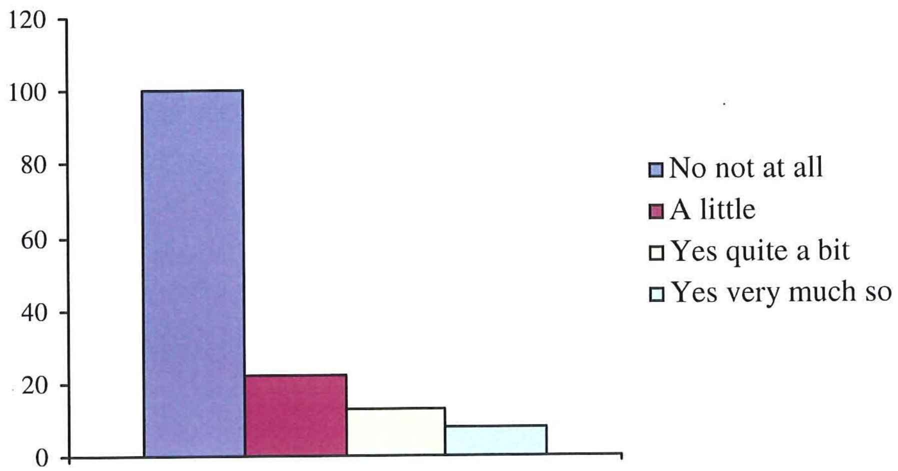
Histogram for responses to Item 1

I get a definate craving for a cigarette when I haven't had one for a while



Histogram for responses to Item 2

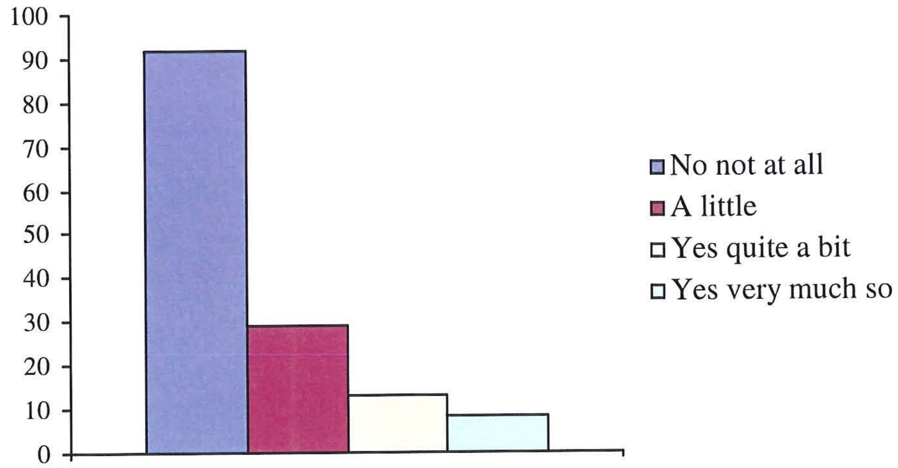
I light up a cigarette without realising that I still have one burning in the ashtray



Appendix 4.5 continued

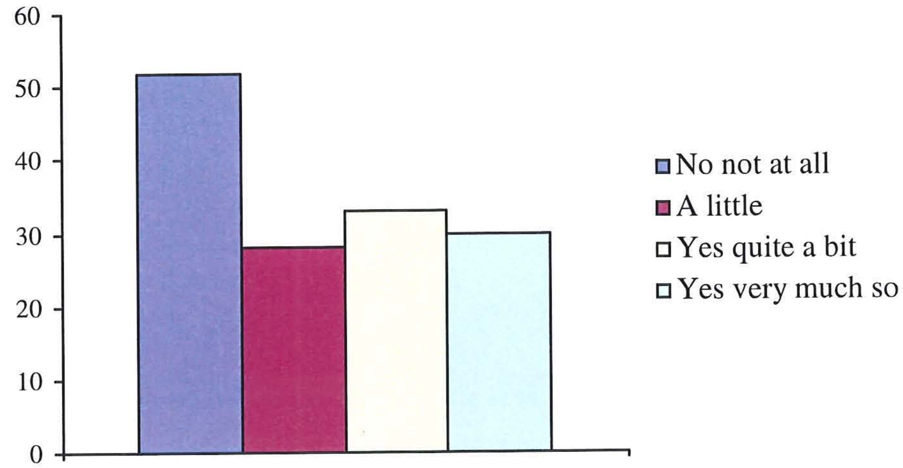
Histogram for responses to Item 6

I think I look good with a cigarette



Histogram for responses to Item 15

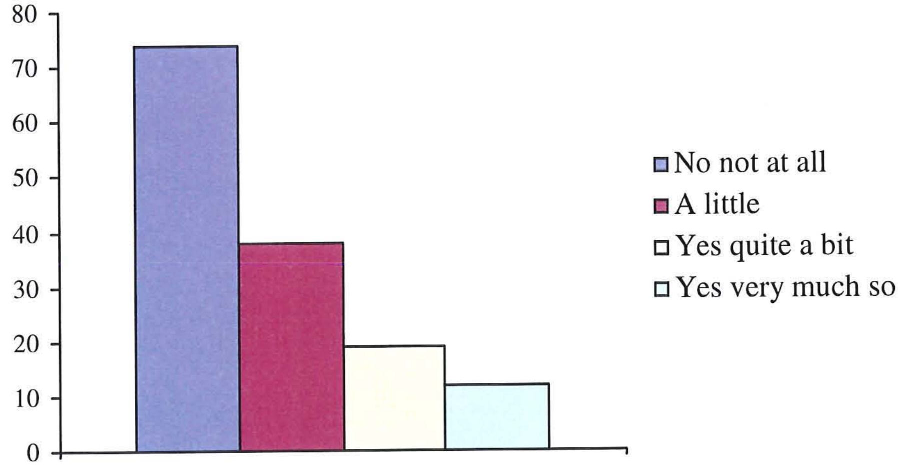
Smoking helps to keep me going when I am tired



Appendix 4.5 continued

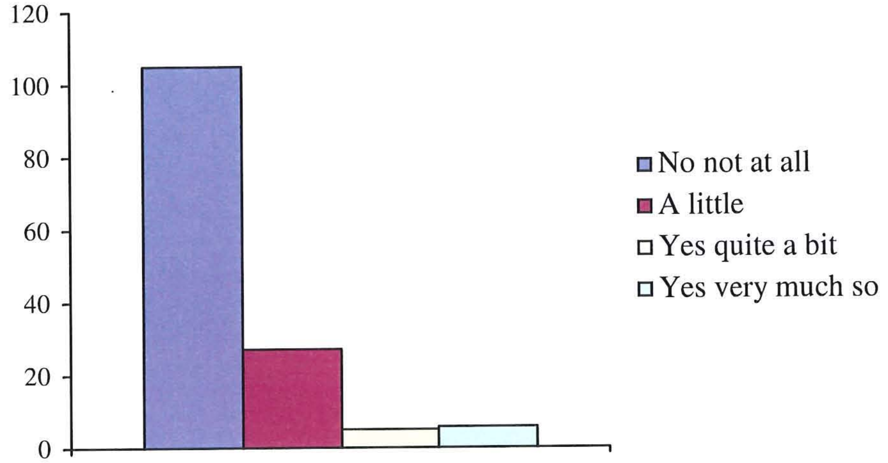
Histogram for responses to Item 17

I find myself smoking without remembering lighting up



Histogram for responses to Item 22

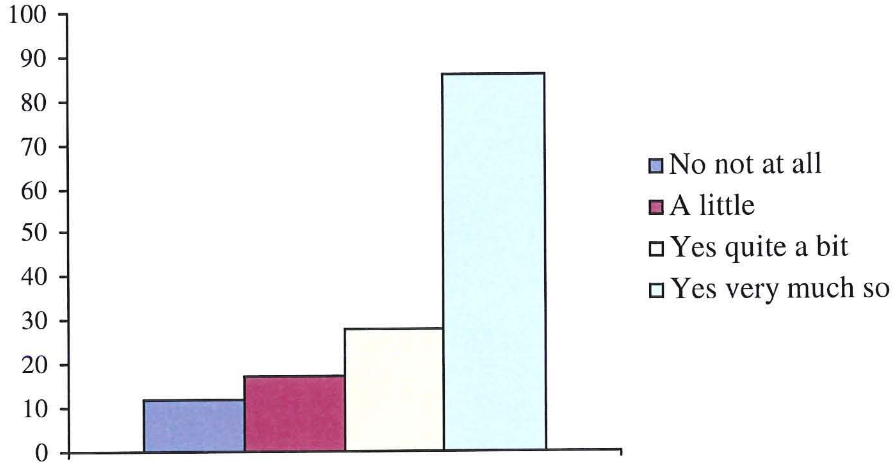
I feel I look more mature and sophisticated when smoking



Appendix 4.5 continued

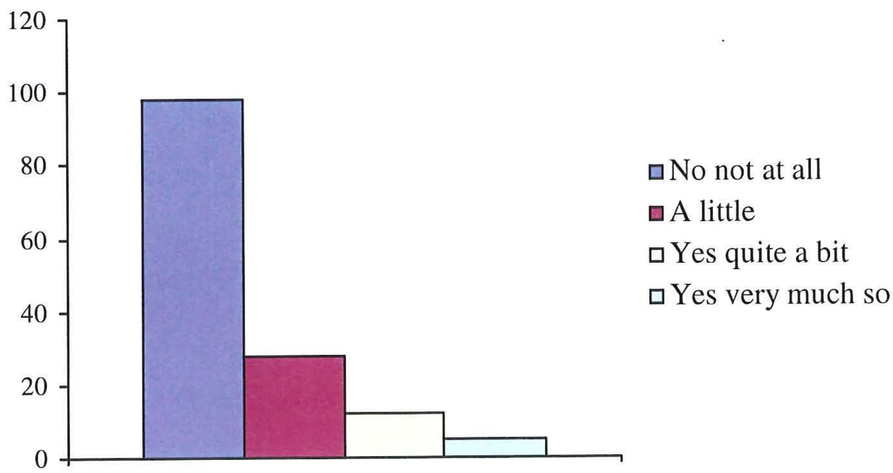
Histogram for responses to Item 24

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



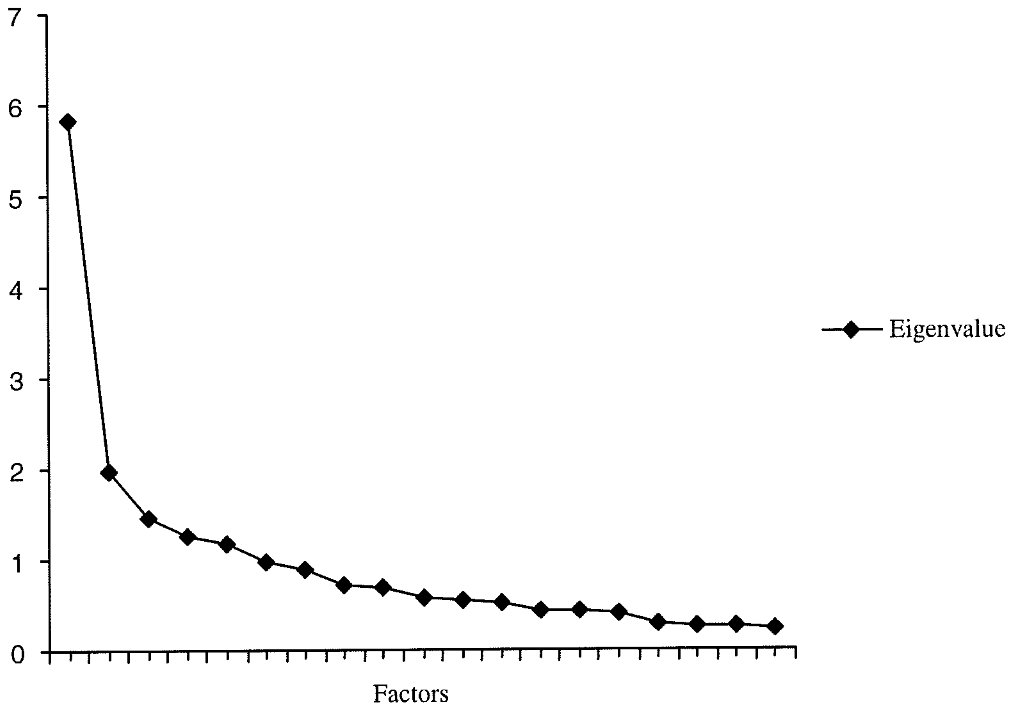
Histogram for responses to Item 26

I feel more attractive to the opposite sex when smoking



Appendix 4.6

Scree plot of Eigenvalues for the SMQ factor analysis.



Appendix 4.7

Revised Smoking Motivation Questionnaire
(19 items, 5 sub-scales version)

Name Date Daily cigarette consumption

Age Sex

How long have you smoked?

Please indicate how much each of the following statements apply to your reasons for smoking. Please draw a circle around the appropriate number.

		NO NOT AT ALL 0	A LITTLE 1	YES QUITE A BIT 2	YES VERY MUCH 3
1	I like a cigarette best when I am having a quite rest	0	1	2	3
2	I get a definite pleasure whenever I smoke	0	1	2	3
3	Handling a cigarette is part of the enjoyment of smoking it	0	1	2	3
4	I smoke when I am worried about something	0	1	2	3
5	I smoke according to a regular routine	0	1	2	3
6	I get a definite lift and feel more alert when smoking	0	1	2	3
7	I smoke automatically without even being aware of it	0	1	2	3
8	I smoke to have something in my hands	0	1	2	3
9	When I have run out of cigarettes I find it almost unbearable until I can get some more	0	1	2	3
10	I smoke more when I am unhappy	0	1	2	3
11	I find it difficult to go as long as an hour without smoking	0	1	2	3
12	I want to smoke most when I am comfortable and relaxed	0	1	2	3
13	I smoke at certain times of the day	0	1	2	3
14	Smoking helps me to think and concentrate	0	1	2	3
15	I get a real gnawing hunger to smoke when I haven't smoked for a while	0	1	2	3
16	I have developed a regular pattern of smoking	0	1	2	3
17	I am very much aware of the fact when I am not smoking	0	1	2	3
18	I smoke to have something to put in my mouth	0	1	2	3
19	I smoke more when I feel angry about something	0	1	2	3

Appendix 5.1

Fagerström Tolerance Questionnaire

How many cigarettes per day do you smoke?

What brand do you smoke?

Do you inhale? **Always Sometimes Never**

Do you smoke more during the morning than during the rest of the day? Yes No

How soon after you wake up do you smoke your first cigarette? **Time in minutes**

Which cigarette would you hate to give up most?

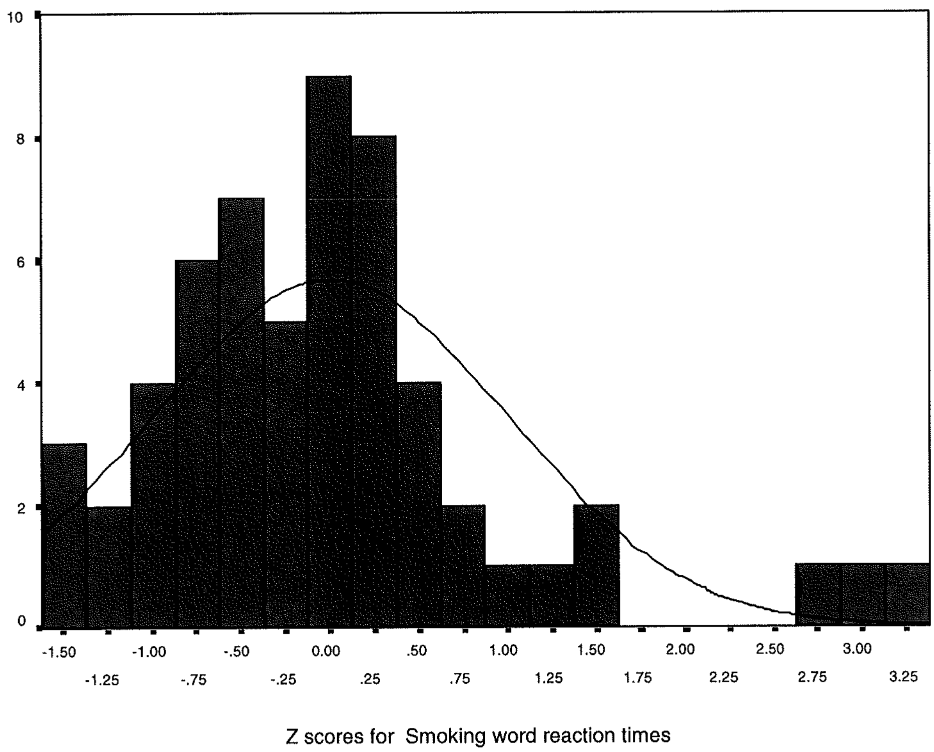
Do you find it difficult to refrain from smoking in places where it is forbidden- for example, in a church, at the library, cinema, and so on ? Yes No

Do you smoke if you are so ill that you are in bed most of the day? Yes No

Note: Questionnaire range is 0-11, with 0 indicating minimum physical dependence and 11 maximum physical dependence. An FTQ score of 6 or more is used to define dependent smokers.

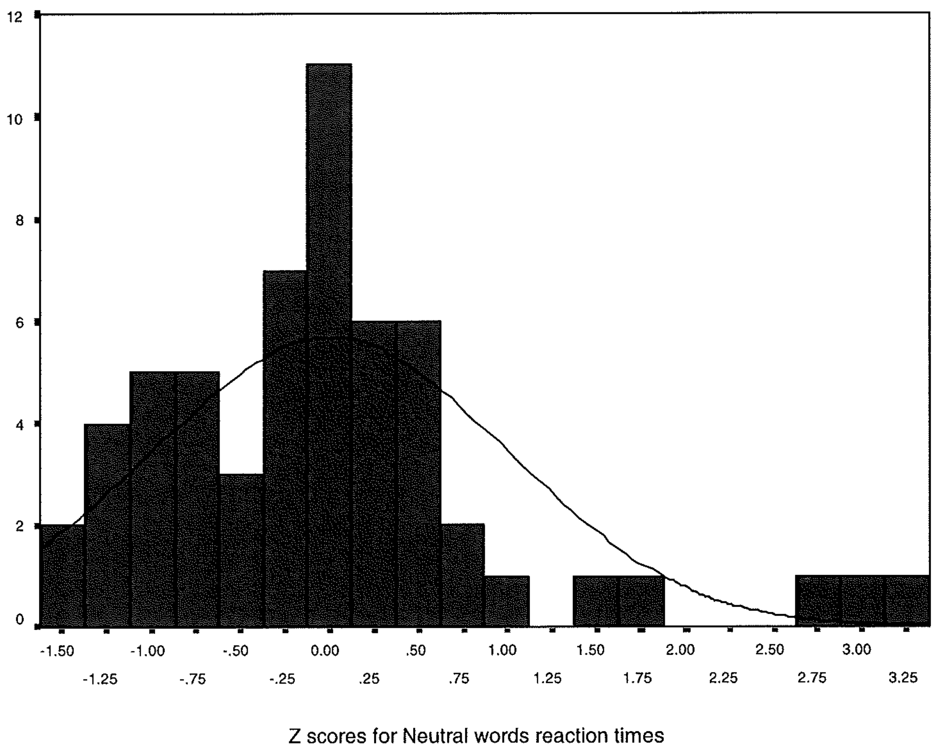
Appendix 5.2

Histogram for smoking-related Stroop reaction times (Z scores).



Appendix 5.2 continued

Histogram for neutral word reaction times (Z scores).



Appendix 6.1

Cigarette craving scale

How much do you want a cigarette right now?

1	2	3	4	5	6	7	8	9	
very much									not at all

How much are you thinking about cigarettes right now?

1	2	3	4	5	6	7	8	9	
very much									not at all

How much did the reaction time test make you think about smoking?

1	2	3	4	5	6	7	8	9	
very much									not at all