The Role of Visual Imagery in Craving

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Abstract

This thesis tests a new theory of craving: The Elaborated-Intrusion Theory of Desire. The theory incorporates aspects of current conditioning, neurophysiological and cognitive theories and expands on existing knowledge of craving. The theory suggests that human desire involves intrusive thoughts and elaborated cognitions and also introduces mental imagery as a key aspect of the craving episode.

There are two broad areas of research conducted in this thesis. The first explored the subjective experience of craving using two questionnaire studies. The results from these questionnaire studies acknowledged the generality of craving, indicating that the subjective experience of desire was similar across different target substances and it confirmed that visual imagery was a component of craving.

The second area of research focuses on this relationship between visual imagery and craving. Experiments 1 to 3 tested visual imagery and working memory manipulations in deprived and continuing smokers. They provide empirical support for the hypothesis that craving can be reduced by a concurrent task that selectively loads the cognitive processes involved in generating and maintaining an image of the craved substance. The final experiment was an intervention study testing the potential for using visual imagery methods to manage cravings outside the laboratory. However, the visual imagery task did reduce smoking behaviour over a one-week 'treatment' period in a group of smokers wanting to quit, an auditory imagery task had a similar effect.

The results overall support the contention of the EI theory that visual imagery is a key component in desire. Despite the equivocal results of Experiment 4, the findings highlight the potential for imagery interventions to help manage craving in therapeutic setting.

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1 The Concept of Craving

We all have an intuitive meaning of the word craving, associated with a strong desire for an object or activity. Craving represents one of the most common and intense experiences in human behaviour. It can be aversive, frustrating and intensive, and, for many, craving represents the central dilemma of addiction. Craving can be regarded as a subjective motivational state, which includes the great emotional significance it has to an individual. It is associated with the maintenance of substance misuse in addicts and can also cause relapse in individuals who are trying to abstain (Pickens and Johanson, 1992; Tiffany, 1995). In 1954, the Expert Committee on Alcohol and the Expert Committee on Mental Health of the World Health Organization met specifically to clarify the use of the term "craving" in alcohol research. Craving was considered to be of great importance in the study of addiction as it was thought to be responsible for both the initiation of excessive drinking and for relapse (Kozlowski and Williams, 1987). The inability to control their craving is often the reason given by individuals when explaining why they lapsed back into drug use behaviour after years of successfully abstaining, and it is sometimes the reason given for the continued use of a substance and the inability to give up (Pickens and Johanson, 1992).

Craving lies at the heart of addiction, from alcoholism to compulsive gambling. Most people understand the sudden desire or need that we often experience for a certain substance or even an activity, which would be the underlying concept of craving. It can cause a great deal of physical and psychological distress in those trying to resist their urges. To understand addiction, we need to fully understand the processes that cause compulsive drug taking behaviour. The transformation from drug user to addict is thought to occur because addicts develop an obsessive craving, rather than an increased

liking, for the substance (Robinson and Berridge, 1993). Thus, craving is thought to play a central role in the study of addiction.

Researchers have used the term "craving" in many different ways, with different operational definitions. There is a great deal of controversy regarding the nature and relevance of the craving concept. Differences range from those that believe craving is a major determinant of drug taking behaviour to those that suggest that craving is a hypothetical construct that can be ignored in scientific study (Pickens and Johanson, 1992). For the former at least, understanding craving is vital to the study and treatment of addictive disorders.

This thesis begins with a discussion of the problems in studying craving with respect to finding a suitable definition and a tool for measuring the phenomenon. It then reviews existing models of craving and focuses on the model that this research is based on.

1.1 Defining Craving

The Oxford English Dictionary defines "crave" as a verb meaning an urgent desire, longing or yearning, which can be used in reference to anything, a substance or even an activity: cravings can be for example, for food, drink, attention or exercise. For medical reasons, scientific research tends to focus upon craving for alcohol or drugs. This is because it is the craving for potentially addictive substances that represent a problem and require a cure or solution. Many of the definitions and models of craving are therefore applied only to such substances. However, it does not seem plausible that there are separate motivational systems for addictive substances and our general motivated behaviours for food and sex (Kavanagh, Andrade and May, under review). A complete definition and model of craving should be applicable to all substances and behaviours. The *International Classification of Diseases (ICD–10-* World Health

Organization, 1992) includes craving as an optional diagnostic criterion for addiction to alcohol or other drugs, defining the term as a strong desire or sense of compulsion to take the drug. The lack of consensus in the area of addiction is shown by the omission of craving from the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-* American Psychiatric Association, 1994*)*.

Craving has been regarded as a subjective motivational state, analogous to emotion, in that it has a motivational significance to the individual experiencing the craving. It has also been associated with a loss of control; in his statement on the subject in 1784, Benjamin Rush identified alcoholism as a disease in which alcohol is the causal agent and the only effective cure was total abstinence. The individual has a loss of control over drinking and there is an inability to stop the drinking once started. In 1960, Jellinek defined loss of control as "extending the given drinking bout after which, again, the alcoholic is able to go on the water wagon". The initiation of a new bout of drinking was ascribed to an impulse, not a loss of control or a compulsion to drink. His research raised a number of questions in the alcoholic treatment research regarding what mediates loss of control.

Wikler's (1948) research on drug abuse defined craving as a strong, almost overpowering urge for opiate use during acute withdrawal. This definition was subsequently generalised to all substance abusers under unspecified conditions. Craving has also been argued to be a tautological concept (Mello, 1972) because craving was most often defined by subsequent drinking behaviour. According to this definition though, if a person drank, then it was because he or she was craving. However, to use "craving" to explain all drinking would not be accurate. Subsequent research carried out on craving showed that this was not entirely the case: Drinking could occur without

craving as well, and many addicts did not experience cravings. Relapse was not always brought about by craving and craving does not inevitably lead to relapse. The association between craving and drug-use is not always a consistent one. If craving was the motivational core of alcoholism then all incidents of relapse should be preceded by a craving episode (Tiffany, Carter and Singleton, 2000). Though abstinent alcoholics complain about experiencing craving (Ludwig, 1988), relapsed alcoholics rarely identify craving as being a major cause of their relapses. Miller and Gold (1994) conducted a study with over 300 drug-dependent subjects who had participated in a rehabilitation program 12 months before the study. Those who were unable to remain abstinent were asked to select a cause for their first relapse from a list of nine reasons, which included craving. Craving was identified as being a primary reason for relapse by fewer than 7% of the participants.

An alternative definition was proposed by Marlatt (1985), who described craving as an epiphenomenon; a cognitive rationalisation used by drinkers to explain relapse, but one which is neither necessary or sufficient to cause relapse. Though this would explain why craving does not always bring about relapse, or why sometimes relapse occurs without craving, it does not provide a complete description of the craving. The theory states that craving has no causal role in behaviour. However, many studies do provide evidence for a link between desire and appetitive behaviour (Swan, Ward and Jack, 1996; Killen and Fortmann, 1997; Ludwig and Wikler, 1974). Rankin, Hodgson and Stockwell (1979) defined craving as a "central state", synonymous with a desire or disposition to drink alcohol. Craving was considered a motivational state, which increased the possibility of seeking and consuming alcohol or other drugs.

Some definitions confuse craving or urge with the intention to consume the desired substance (Buydens-Branchley, Branchley, Fergeson, Hudson and McKernin, 1997; Marlatt, 1985). The failure to distinguish between desires and their triggers, intentions and behaviour lead to problems in the investigation of the causal relationship between the concepts. More recently, Pickens and Johanson (1992) in a summary of a National Institute of Drug Abuse meeting concluded that: "Craving is a subjective state in humans that is associated with drug dependence, but little is known about its determinants, relationship to drug taking and measurement." Their analysis of the craving research indicates that many questions regarding the definition, aetiology and mechanisms of craving in humans remain unanswered. The lack of a valid, uniform definition means that clinicians cannot accurately assess their patient's level of craving or measure the changes in craving that might indicate an improvement or decline in the patient's condition (Anton, 1999). The lack of a precise definition of craving therefore can result in misrepresentations on the part of both the experimenters and the subjects.

To summarise, despite the doubts about the concept of craving, it is thought to be a key symptom of addictive disorders such as alcoholism. Craving can be defined as an intense desire, want or need for a substance or even an activity. It is often described as being the driving force behind the continued use of a drug in spite of increasingly adverse circumstances and can be regarded as being the underlying basis of the onset of addiction. Craving and desires could lead to consumption of the desired substance but the appetitive behaviour is not inevitable. Consumption can also take place without craving. A complete description of craving should recognise the strong motivating force that it is but also acknowledge that it is also moderated by other factors, such as the availability of the desired substance or self-control.

1.2 Measuring Craving

The measurement of craving usually does not receive enough attention and any advancement in the study of craving is restricted by inconsistent measures. The lack of a single accepted measure of craving means that the selection of an appropriate measure for research purposes is difficult. As mentioned earlier, different researchers use different definitions of craving and the debates on a definition of craving also lead to difficulties in selecting a single measure for them. The exact nature of craving and how it should be measured is important to the study of addiction. The relatively weak relationship between craving and behaviour could be owing to problems with the subjective assessment of desire. Individual differences in measurement of desire in people who are trying to control their consumption would impair the ability to predict behaviour from desire.

Measurements of cravings have relied mostly on self-report techniques. The reason for this is that craving can be defined as a subjective "felt" desire and the subjective experience of craving is assumed to be similar across persons, differing only in intensity. Thus, self-report scales are often made up of a Likert-type scale that assesses the level of craving, or include statements that require a simple yes/no response. Some of the questionnaires used also attempt to analyse multiple aspects of craving (e.g. Shiffman and Jarvik, 1976; Tiffany, 1990). Schuster, Greenwald, Johanson and Heishman (1995) found that a multi-item craving questionnaire was better at detecting changes in craving than responses to a single item like "I want to shoot up now".

Subjective self-report appears to be the only viable assessment technique. However, this is subject to a great deal of controversy as these measures can be distorted by a variety of factors such as retrospective recall, social demand, self deception and the variability

in semantic interpretation of the scales. For example, the subjects might interpret the term "*craving*" in different ways: Some might regard it as a "strong desire" for a substance while others might consider any desire to be a craving for a substance.

One of the more significant challenges with self-report measures is the bias owing to retrospective recall. Some of the questionnaires that assess craving require the subject to recall and summarise their craving experience over a period of time. For example, individuals are asked to rate their craving for a particular day or week (West, Hajek and Belcher, 1989; Anton, Moak and Latham, 1995). Their memories, however honest and willing the subject is, would be subject to bias (Hammersley, 1994). Recall of past experience would be influenced by the subjects' current state, their intervening experiences and the salience of experience; this would lead to either an overestimation or underestimation of their past craving experiences. These are, however, problems that are faced in the measurement of any subjective phenomenon such as emotions and attitudes, and there are measures that can be taken to reduce the limitations of self-report assessment. For example, the purpose of the study or the implications of responses could be concealed from the respondents. Self-report can provide useful information about a person's craving and is continued to be used in the measurement of craving (Tiffany et al., 2000).

An alternative method would be to collect data on subjects' current experience, which would provide a more accurate representation of the episode as it occurs. This could be carried out in a laboratory where they fill out questionnaires on how they are currently feeling. Craving studies involve the assessment of momentary states in the natural environment of a subject over time. Ecological Momentary Assessment (EMA; Stone and Shiffman, 1994) has been used to collect data on lapse and temptation antecedents

in real time, in the subjects' natural environment. Participants carry palm-top computers and use them to record lapse and craving episodes. This provides information about the natural history of the craving phenomenon as well as its relationship to the environment. This method has been shown to be capable of picking up small within-day variations of mood and activity associated with small-scale daily life events, the sort of changes that might trigger a lapse in smoking (Shiffman et al., 1997).

A variety of other measurement techniques has been suggested. For example, the use of facial coding to assess the affective expressions that attend craving, or the assessment of peripheral autonomic responses that may accompany craving, have been considered. However, none of these methods have been adequately validated (Shiffman, 2000) and they are also subject to a lack of specificity.

Problems also lie in the characterisation of cravings as it is difficult to determine exactly how strong the desire must be before it can be classified as a craving (Wiengarten and Elston, 1990). The descriptive approaches used to define and measure craving suffer from the normal problems in quantifying self-report and, therefore, are subject to individual differences in their assessment. The arbitrary scales that the subjects are asked to use in the ratings of their cravings are taken to equal the magnitude of the craving being considered. An important factor that should be considered is that it might be difficult to generalise inferences about craving scales being used in the different studies. Craving might be difficult to quantify, define and even measure. However, researchers such as Anton, Moak and Latham, (1995), Bohn, Krahn and Staehler (1995) and Singleton, Tiffany and Henningfield (1995) have developed improved instruments for assessing the severity of craving with new rating scales that have greater reliability in measuring and defining craving. Their studies focus on the development and

validation of new questionnaires of alcohol craving and drinking urges in abstinent alcoholics.

The relationship of concepts such as craving to clinical outcomes has become more reliably evaluated with the improvement in the methods used in alcoholism treatment research. The development of drugs such as Naltrexone and Acamprosate, aimed at attenuating drinking behaviour, brought about a new interest in craving, because the studies that are carried out to test the effects of these drugs have found that the drugs achieve their effects through reductions in the cravings experienced (Drummond, 2001). Similarly, Zyban works to reduce cigarette craving, and has been used successfully in smoking cessation. Evidence presented suggests that the drugs work as novel agents that suppress craving (Littleton, 1995). However, the fact that the drugs suppress craving has been challenged (Lowman, Hunt, Litten and Drummond, 2000) on the basis that medication-reduced craving may not translate into the prevention of relapse. This was because craving and relapse tended to be at best poorly coupled or even unrelated. Though the development of these medications has renewed the interest in cravings, there remains a lack of consensus about the nature of craving and the models that characterise it. Current literature does not negate the importance and relevance of craving in the study of addiction, but it remains a challenge for researchers to define the conditions under which craving occurs and its relationship to addictive behaviours.

1.3 The Problem of Craving

Though there is a great deal of controversy regarding the technical definition and use of craving, it is regarded as being vital to the study of addiction, as one of the central difficulties experienced by those trying to abstain or regulate their intake is managing their subjective experience of urge. Jellinek (1960) viewed craving for alcohol as the

key underlying disorder in the Disease Concept of Alcoholism. In 1976, Edwards and Gross described craving or "the subjective awareness of the compulsion to drink" as one of the seven key elements of the Alcohol Dependence Syndrome. Urges and cravings are major problems encountered by addicts who are trying to quit. Craving for cigarettes is described as a major component of the nicotine withdrawal syndrome experienced by abstinent smokers (American Psychiatric Association, 1987; Hughes and Hatsukami, 1986; Shiffman and Jarvik, 1976). Long-term studies carried out by Fletcher and Doll (1969) indicate that more than 20% of smokers report experiencing desires and urges to smoke even 10 to 14 years after quitting.

Though the correlation between subjective craving and subsequent consumption is relatively weak (Tiffany, 1990, 1999; Weiss, Griffin and Hufford, 1995), there have been associations of craving and relapses in addictive disorders (Swan, Ward and Jack, 1996). People who have remained abstinent for years can relapse to alcohol abuse as craving challenges their behavioural control and can be very disruptive. They often report an intense desire for alcohol as well thoughts about drinking that appear suddenly or increase with time. The relationship between craving and relapse can be summarised by Shiffman's (1979) statement that "The urge to smoke, when it becomes stronger than the ex-smoker's determination to quit, leads to relapse".

Craving can be used to predict relapse. A study by Shiffman et al. (1997) monitored the smoking urges of 214 smokers who had recently quit smoking. They used palm-held computers to assess urges at random times, as well as rating urges on waking and when the participants experienced a temptation episode. They examined the natural history of urges and temptation episodes and the effects they had on subsequent lapse. They found that urge intensity declined after cessation and was no more intense and less frequent

during abstinence than ad lib smoking. However, during abstinence the urge creates a conflict between the drive to smoke and the desire to remain abstinent, which causes the cravings to be experienced as frustrating and disruptive. Their results showed that, after controlling for baseline urge intensity and nicotine dependence, morning urge intensity was able to predict day-to-day lapse risk. Their findings contradict the idea that urges and craving are epiphenomenal and instead support the motivational aspects of the experience.

A study by Killen and Fortmann (1997) on 2,600 ex-smokers found a highly significant relationship between craving and their relapse over the following 12 months. High levels of cravings are associated with increased probabilities of relapse, particularly immediately after a treatment period (Anton et al., 1996). Studies have also found associations between craving and work to obtain the desired substance, which underline the causative nature of the craving experience (Ludwig and Wikler, 1974). The importance of thoughts about the desire substance is also demonstrated by results from a study by Mischel, Ebbeson and Raskoff-Zeiss (1972). Children were offered the choice between a small but immediate reward or a delayed and more substantial one. If the children attended to the desirable qualities of the reward then they were more likely to wait for shorter periods of time than when they were distracted from desire thoughts. Their findings support the relationship between consummatory thoughts and subsequent consumption.

Treatments that reduce craving have also been shown to reduce subsequent alcohol use (Monti et al., 1993). Many of the drugs used in treating alcohol addiction reduce alcohol consumption by reducing the craving for alcohol (Swift, 1999). Volpicelli, Alterman, Hayahida and O'Brien (1992) showed that patients who received Naltrexone reduced

both their drinking and their craving for alcohol. Naltrexone has also been shown to be most effective in reducing drinking in patients who reported high levels of craving (Jaffe et. al., 1996). There are also preliminary reports that prove the effectiveness of Acamprosate in relapse prevention in the treatment of alcoholism (Sass, 1994; Poldrugo, Chabac and Lehert, 1994; Lesch et al., 1994; Pelc, Le Bon and Verbanck, 1994). It reduces the number of days that are subsequently spent drinking after the start of treatment for alcohol dependence and also reduces the number of drinking bouts that are described by the individual as "out of control" (Littleton, 1995). The effectiveness of these drugs in the treatment of substance abuse is thought to be owing to their effect on craving.

The role of urges in relapse has been assessed using a variety of methods. Monti et al. (1990) used the urge to drink and other responses to the Alcohol-Specific Role Play Test (ASRPT – a role-play assessment measure used in prediction studies) at the end of residential treatment to predict drinking during a 6-month follow-up period. They found that the urge to drink alone significantly predicted drinking quantity over the follow-up period. Similarly, drinking quantity was also predicted by urge to drink, following a urge-induction procedure that was designed to produce stress. The strongest predictor of subsequent drinking behaviour was the urge to drink that persisted through the 3-minute recovery period after each role-play test. The results showed that the degree of urge after treatment can predict subsequent drinking behaviour and that lasting urges, after the initial high-risk situation, may be predictive of outcome. Alcoholics with greater urge to drink in response to ASRPT drank more alcohol during the six-month following treatment (Monti et. al., 1990).

Killen, Fortmann, Newman and Varady (1991) examined the factors associated with craving over an 8-week treatment period. They measured craving, withdrawal symptoms and several other psychological and behavioural variables that may influence cessation of smoking or maintenance of it. Their results showed that dependence was consistently associated with craving at 48 h, 4 and 8 weeks post-cessation. The measure of craving obtained at 48 h was also associated with treatment outcome. Forty-three percent of participants with low initial craving scores were abstinent at a 2-month follow-up compared to only 23% of participants with high craving scores. The results presented in their study supports the idea that craving is an important factor in maintaining dependence and producing relapse even after physiological withdrawal is complete.

Craving has also been conceptualised within the framework of incentive motivational theories of behaviour (Bindra, 1968; Bolles, 1972) and has been described as the incentive motivation to self-administer a psychoactive substance that was previously consumed (Markou et al., 1993). Managing the subjective experience of urge is one of the central difficulties faced by those trying to regulate the intake of substance; it is assumed that the stronger the urge to drink, then the more likely an individual will drink in response. Once an individual has decided to stop using a substance, the initial problem the individual must cope with is dealing with craving for that substance. The craving can become so intense that the individual gives in during the initial withdrawal period immediately after quitting. In a study conducted by Marlatt et al (1984), 17% of smokers who attempted to quit on their own were unable to stay off cigarettes for more than 24 hours after quitting. Clearly, the first few days are a great risk period in terms of giving into cravings (Marlatt and Gordon, 1985). Coping plays an important role in preventing smoking relapse. Shiffman (1987) defined coping among smokers as any

attempt to resist temptation and avoid smoking. Drobes, Meier and Tiffany (1994) carried out a study looking at the effects of urges on the coping skills of smokers. They obtained descriptions of how the subjects would cope with circumstances that placed them at high risk for relapse. They incorporated urge contents into the scenarios used in the study to examine the effect of urge on coping responses. The results showed that manipulation of urges had an impact on cognitive and behavioural measures and that smoking urges do contribute to relapse.

The strength of the craving phenomenon is displayed by an example from a study by Stockwell and colleagues (1987). After consuming a priming dose of whisky, one subject experienced such a strong urge to continue drinking that his entire body shook, and his pulse rate increased from 100 to 180 in about 2 minutes; the subject was unable to resist drinking all the available alcohol.

Cravings are experienced as being frustrating and intrusive; they dominate our thoughts and cause a disruption in our daily activities. Cepido-Benito and Tiffany (1996) conducted a study exploring the cognitive demands of craving in cigarette smokers. They used an imagery procedure to induce craving in the laboratory and got subjects to complete a simple task where they had to press a button when they heard a tone. Imagery-induced craving was seen to disrupt performance on the task, compared to the neutral imagery condition, as smokers took longer to press the button during craving imagery.

Further studies have also shown that cravings cause a disruption in performance of cognitive tasks. Sayette et al. (1994) investigated reaction times as a measure of attentional deficits produced during alcohol cue exposure. Exposures to drug cues are known to elicit cravings or urges to drink (Rohsenow, Niaura, Childress, Abrams and

Monti, 1990, 1991). People who do relapse often report being unable to use any behavioural or cognitive coping skills (Shiffman, 1982), as craving can play a disruptive role on coping skills. Sayette et al. found that the subjects required more time to respond when exposed to alcoholic cues, supporting the idea that the experience of cravings and urges cause a decrease in cognitive performance on concurrent tasks.

Studies carried out by Hillebrand (2000) on opiate addicts also suggest that cravings and urges represent the operation of cognitively demanding processes. Participants completed a dual-task paradigm where they responded to a probe stimulus while simultaneously listening to imagery scripts (drug script or neutral script). Reaction times in the drug cue condition were considerably greater than in the neutral condition. The cognitive demands of cravings produce slower reaction times.

Understanding the role of craving in addiction is important in that it can be assumed that the transformation of drug-use behaviour into compulsive drug-use behaviour occurs because addicts develop an obsessive craving for the drug in question (Robinson and Berridge, 1993). The craving is difficult to resist and so leads to drug seeking and drug use. Though drug dependence is often characterised by craving and craving is considered a key cause of relapse, the connection between craving and drug use is not very clear. A clearer understanding of craving and of its relationship to behaviour would be beneficial in the study of addiction.

2 Theories of Craving

The concept of craving has received a great deal of attention. Recent years have seen an increase in attempts to define, measure and explain the phenomenon (Kozlowski and Wilkinson, 1987; Pickens and Johanson, 1992; Tiffany, 1990). The existing theories of craving can be classified into three main categories: conditioning, neurophysiological or cognitive models. Some theories provide more specific predictions about the nature of craving and how they occur whilst other theories are more applicable to the study of addiction rather than being craving-specific. This chapter begins with a discussion of the different models of craving, before focusing on the theory of craving used in this research. The Elaborated-Intrusion theory of desire (EI theory – Kavanagh, Andrade and May, under review; May, Andrade, Panabokke and Kavanagh, 2004) is described in detail and compared to the leading cognitive theory of craving (Tiffany's model of cognitive processing, 1990).

2.1 *Conditioning Theories*

The concept of classical conditioning (Pavlov) has had an enormous impact on theories of alcohol and drug craving. Conditioning models of craving propose that craving arises from conditioned appetitive behaviour (Niaura et al., 1988). Stimuli that are repeatedly paired with withdrawal become conditioned stimuli which in turn elicit the conditioned withdrawal effects and generate craving (Tiffany, 1999). Addicts then seek out the target substance in order to relieve the conditioned withdrawal effects. After repeated withdrawal episodes, being in a particular place would be enough to trigger the conditioned withdrawal reactions and bring on a craving episode.

One of the more influential conditioning models was presented by Wikler (1948). This conditioned-withdrawal model proposed that neutral stimuli (e.g. sight of a needle and

syringe or a watching someone pick up and hold a cigarette), over the course of many pairings with drug taking, elicit physiological withdrawal responses through a process of conditioning This conditioned withdrawal would then lead to relapse through the desire to relieve the unpleasant conditioned withdrawal experience. Here, craving is regarded as a negative and dysphoric state and also the key element of conditioned withdrawal that drives the relapse process (Ludwig, Wikler and Stark, 1974).

This model was expanded by Drummond, Cooper and Glautier (1990). A cue such as the sight or smell of a drink is repeatedly paired with a falling level of blood alcohol on the morning after a heavy drinking session when the drinker is in a state of alcoholic withdrawal. After a period of abstinence, the sight or smell of a drink can elicit a conditioned withdrawal response, which would resemble alcohol withdrawal. According to this model, since the craving is part of the withdrawal, conditioned craving is elicited as part of the conditioned withdrawal response. Drinking then relieves the craving and the withdrawal symptoms.

A related conditioning model was also put forward by Siegel (1989). This model draws on the opponent process theory proposed by Solomon and Corbitt (1974) and suggests that over the course of substance use, the body develops opponent processes that are homeostatic responses, which counteract the drug's effects over the course of a drinking or drug-taking career. According to this model, if a drug causes a positive hedonic state, the homeostatic response would be negative or displeasure. This opponent process gradually develops in size and duration and, according to Siegel, this leads to the development of drug tolerance. Similar to Wikler's model, this model suggests that on exposure to cues, previously associated with drug consumption, the conditioned responses will be experienced as withdrawal and will be negatively hedonic.

However, these theories describe craving as a negative state associated with withdrawal effects and do not explain why some addicts report craving as a pleasant mood state (Drummond, 2001). It is possible that cues are associated with pleasurable drugs effects during conditioning. Some addicts report that the craving experience can often be pleasurable rather than withdrawal-like and, the repeated pairings with drug taking and unconditioned pleasurable drug effects, environmental cues can elicit drug-like conditioned responses (Drummond, 2001).

An alternative conditioning model was described by Stewart, de Wit and Eikelboom (1984). They acknowledge that the craving experience can often be pleasant rather than unpleasant, such as withdrawal. Their theory suggests that, particularly in the case of stimulant drugs, environmental cues following repeated pairings with drug taking and pleasurable, unconditioned drug effects, could come to elicit drug-like conditioned responses, which would include craving. This pleasant state, caused by the conditioned responses, then primes the individual to take more of the drug through positive reinforcement processes.

To further explain the relationship between conditioned responses and drug cues, Drummond, Tiffany, Glautier and Remington (1995) put forward a cue reactivity model, which examines the nature and magnitude of conditioned responses to the cue presentations of alcohol related stimuli. They propose that cues that are previously associated with drinking behaviour can elicit cue reactivity under certain conditions, and that cue-reactivity can either be autonomic (salivation), symbolic-expressive (subjective craving) or behavioural (drug-seeking behaviour). The cue reactivity paradigm involves the exposure to cues and measurement of a variety of responses. Symbolic expressive reactivity is usually measured using questionnaires. Physiological

reactivity is measured using changes in heart rate, skin temperature and salivation. More recently, neuroimaging methods have also been used to study changes in brain activity on cue exposure (Drummond, 2000). Though the three modalities of cue reactivity are thought to be conceptually distinct, they are often correlated in practice (Glautier and Drummond, 1994). This may indicate a shared underlying causal mechanism (Drummond, 2000). However, Tiffany (1995) argues that there is a lack of support for the link between craving and relapse. Drummond also makes a distinction between withdrawal craving, which occurs during withdrawal only and can occur in the absence of cues, and cue-elicited craving, which only occurs in the presence of substance-related cues. He suggests that this distinction may explain the limitations of craving measures as predictors of relapse and that the two types of craving may be subject to many influences such as individual differences and bias (Drummond, Cooper and Glautier, 1990).

Tiffany and Conklin (2000) examined 30 studies from the alcohol cue-reactivity literature and observed that, across all the studies, it would have been possible to calculate at least 73 correlation coefficients between craving reports and the autonomic measures (heart rate, sweat-gland activity, salivation etc.) that were taken. The research however reported only 14 of these possible correlations, of which only three were significant. They conclude that there is little evidence that cue-specific craving and cue-specific autonomic reactions display any systematic co-variation. Both conditioning models and compensatory response models, and those described earlier, have problems when trying to explain the lack of correspondence between physiological and cognitive responses to cognitive cues (Tiffany, 1990). Tiffany's review (1988) consisted of a number of studies, which reported correlations between physiological variables and self-reported urges or between drug-consumption measures and self-reported urges. The

studies involved either alcoholics or cigarette smokers who were exposed to drug-related or neutral stimuli. These included alcoholics sniffing bottles of alcohol (Cooney, Baker, Pomerleau and Josephy, 1994; Kaplan et al., 1985; Monti et al., 1987) or having a smoker take a puff on a cigarette (Baker, Morse and Sherman, 1987). He noted that many of the correlations between physiological responses and self-reported urges were not reported in the studies and in some cases the authors had stated that the correlations were not significant. He concluded that the results from the studies suggested that the physiological responses were at best only modestly correlated to self-reported urges. This provides a problem for conditioning models of craving that suggest that conditioned physiological responses provide a substrate for craving. Conditioning models are unable to provide a complete account of a complex phenomenon like craving.

2.2 Neurophysiological Models

These models of craving attempt to incorporate craving with the processes that maintain substance abuse and focus mainly on the neurochemical and molecular changes that take place in the brain during the first phase of drug use, which lead to dependence, addiction and drug abuse. Drugs are thought to act through similar neurophysiological mechanisms, which are based on the abnormal activation of the dopamine system. The permanent neural changes that take place are thought to underlie the addictive process and cause the cravings that are experienced during abstinence (Fernandez-Espejo, 2002). Some of the models in the area regard drug addiction as a chronic relapsing brain disorder (Koob, 2000) that is characterised by neurobiological changes that lead to the compulsion to take the drug, and a loss of control on the intake of the drug. The neurochemical systems that are believed to be involved in addiction are then used as a basis for the development of pharmaco-therapies for drug addiction.

The conditioning process and the cognitive processes related to continuous drug use are explained using a neurochemical basis. An example of one such theory is the Psychomotor Stimulant Theory of Addiction (Wise and Bozarth, 1987). The theory proposes that all addictive drugs have psychomotor stimulant actions. The stimulant actions of different drugs have shared biological mechanisms, and these mechanisms are homologous with biological mechanisms of positive reinforcement. The model associates addiction with operant reinforcement, specifying independent psychomotor stimulant properties as predictors of whether a given drug will prove reinforcing in an operant situation. The main concept in this theory is that the reinforcing effects of the drugs are predicted from their ability to induce psychomotor activation. All addictive drugs are believed to have psychomotor stimulant properties. The theory suggests that the biological mechanism of these properties is the same as the biological mechanism of the reinforcing effects of the drugs: the activation of the dopaminergic circuitry of the medial forebrain bundle. This circuitry is also activated by stimuli that are systematically associated with substance use. Wise and Bozarth review evidence that links the reinforcing and locomotor stimulating effects of psychomotor stimulants and opiates to this brain mechanism.

Another model in this area is the Incentive Sensitisation Theory (Robinson and Berridge, (1993). Though it is used as an explanation for addiction and addictive behaviours rather than craving itself, it does make certain predictions about the nature of craving. It suggests that "the defining characteristics of addiction (craving and relapse) are due directly to drug-induced changes in those functions normally subserved by a neural system that undergoes sensitisation-related neural adaptation" (Robinson & Berridge, 1993, p. 249). Craving is defined as a conscious experience that occurs when the individual pays excessive attention to the drug-related stimuli or considers the

stimuli excessively attractive. Repeated exposure increases the attention or perceived attractiveness of the stimuli. The theory makes a distinction between "wanting a drug" and "liking a drug" and splits reward-seeking and compulsive drug use behaviour, two common aspects of unitary craving models, into two independent neurochemical systems. Robinson and Berridge propose that the neural system responsible for both drug seeking and drug taking becomes sensitised by repeated drug use. This system is responsible for incentive motivation and reward and is separate from systems that mediate the pleasurable effects of drugs. "Wanting" is argued to be associated with a sensitised incentive motivational system and they propose that the mesotelencephalic dopamine projections provide the neural substrate for drug wanting. This is different from "liking", which is used to describe the pleasurable affective states produced by addictive drugs. Endogenous opioid neurotransmitter systems and the activation of benzodiazepine GABA systems within the brain stem are suggested as neural substrates for drug pleasures. Stimuli associated with drug use become increasingly able to control behaviour because the neural system that mediates "wanting" become progressively sensitised. "Wanting" develops into obsessive craving and brings about compulsive drug seeking and drug taking behaviour. Robinson and Berridge propose that the progressive increase in drug wanting that characterises addiction is not accompanied by an increase in the pleasure derived from drugs. Furthermore, they suggest that wanting may sometimes occur without conscious thought and, thus, relapse may occur without conscious awareness. The drugs can activate positive core processes than can occur outside conscious awareness. The model describes craving as being epiphenomenal to the hypothesised unconscious process (wanting) driving addiction and relapse. It is not clear how the sensitisation process can be altered either pharmacologically or psychologically. Both this model and the one proposed by Wise (1988) regard

subjective craving as an epiphenomenon, and do not acknowledge the causative nature of craving discussed in the previous chapter.

A recent neurophysiological model by Verhuel, Van den Brink and Geerlings (1999) suggests three types of cravings that are related to three different neurochemical pathways. They suggest that reward craving or the desire for the rewarding or enhancing effects of alcohol might result either from a personality style that is characterised by a reward seeking or a dopamingeric/opiodergic pathway or a combination of both. The reward craving is one of the pathways discussed in their model. The second pathways involves relief craving, where Verheul et al. suggest that the desire for the reduction of tension of arousal might result either from either γ-aminobutyric acid (GABA)ergic/glutamatergic dysregulation, a personality style characterised by reactivity to stress, or a combination of both. The third pathway deals with obsessive craving, which is defined as a lack of control over intrusive thoughts about drinking which results in impairment in functioning. This is thought to result from serotonin deficiency or a low constraint, disinhibition personality style, or both. The model attempts to bridge the gap between theories by considering all the different factors that are important in the nature of craving and its underlying mechanisms. An important factor suggested in the model is that craving types may in fact be phenomenologically inseparable and that psychobiological and neurochemical methods would be necessary in the evaluation of craving. The model does not claim to provide a definitive framework to explain craving, but it does propose that it would stimulate further research into the area.

Conditioning models draw upon existing knowledge of the general learning theory and are useful in explaining the results of studies carried out on craving. Similarly,

neurophysiological models are important in providing a description of the mechanisms involved in the experience and also in the development of pharmacological treatments. A biological substrate is necessary for the occurrence of craving and knowledge of brain functioning is important when studying craving. Though the effectiveness of these relapse prevention drugs would support the validity of these neurochemical mechanisms, it does not detract from the need for cognitive models and associated treatment. Cognitive behavioural treatments (CBT) are known to add to the benefits of these drugs (Monti et al., 2001). The descriptions of craving provided by conditioning and neurophysiological theories are limited to the discipline involved and fail to provide a complete account for the phenomenon. Most of the theories and models consider craving to be a consequence of the addictive behaviour rather than causing the behaviour and, though they acknowledge cognitive processes as being central to the concept of craving, they do not elaborate on how these processes might operate. Furthermore, these models tend to focus on the causes of craving and treatment is directed to stopping the craving from occurring. They do not provide an account of what occurs after the craving has been triggered. Thus, once the craving has occurred, the models are unable to suggest ways of managing or coping with the craving. For a treatment technique to be effective, it should allow patients to manage their cravings without giving into them. Research that explores the cognitive concepts associated with the craving phenomenon would be beneficial to the study of addiction, as a cognitive level of explanation would help in understanding all the cues and cognitions that are involved with the craving experience.

2.3 Cognitive Approaches to Craving

Many of the conditioning and neurophysiological models recognise that certain cognitive processes play an important role in the development of craving. The operation

of these processes can only be fully understood, most appropriately, within a cognitive model. Cognitive psychology has played an increasingly important role in the investigation and treatment of alcoholism, which emphasises the need for understanding, monitoring and using alcohol craving as part of a structured alcoholism treatment approach (Marlatt and Gordon, 1985). Identifying the cognitive experience implicit in the expression of craving can inform clinicians of the patient's deficiencies in cognitive self-regulation and other coping skills (Toneatto, 1999). Cognitive factors are known to be associated with smoking relapse. Self-efficacy or the confidence in the individual's ability to maintain abstinence is positively correlated with maintenance of smoking cessation (Bandura, 1977). The use of cognitive coping tactics also appears to be associated with successful abstinence. Furthermore, though neurophysiological models have been successful in developing pharmacological treatments for craving and research has shown that the success of drugs such as Naltrexone comes from its impact on craving (O'Malley, Krishnan-Sarin, Farren, Sinha and Kreek, 2002), this does not detract from the need for cognitive models and associated psychological treatment methods. Research has shown that combining cognitive behavioural therapy with drugs has added success (Monti et al., 2001). The maintained effectiveness of the drugs, once the patient stops the medication, is primarily owing to the skills acquired from CBT (O'Malley et al., 1996). These results support the need for cognitive models of craving and associated treatment. The key cognitive model of craving is the Cognitive Processing Model proposed by Tiffany in 1990, which presents an approach to craving that is distinctly different from the traditional view of the form and function of craving.

Tiffany distinguishes between automatic and non-automatic processes, characterising automatised processes as being fast, stimulus-bound and occurring without conscious control. This model postulates that drug use behaviour, which includes behaviours

involved in the seeking out of the target substance and the consumption of it, becomes an automated process after repeated use (like driving a car). The behaviour, over a long history of drug use, becomes effortless and difficult to control. For example, a smoker might reach for his cigarettes, take one out and light it without controlled conscious awareness. According to the model, this automatic drug use behaviour occurs independently from the cognitions that control craving; craving does not occur during a typical drug-use sequence. A core proposition of this cognitive model is that alcohol or drug use can operate independently of the processes that control self-reports of craving (Tiffany and Conklin, 2000).

Tiffany suggests that cravings are a result of non-automatic processes that require concentrated effort and have limited cognitive capacity. Thus craving represents the activation of non-automatic processes that are activated in parallel with automatised drug-use sequences (Tiffany and Conklin, 2000). Activation is thought to occur when the automated behaviour is impeded, which can occur in two ways. Firstly, an automated behaviour can be impeded by an external environmental factor in a normal addict who is not trying to abstain, like the unavailability of the target substance at that moment in time. Secondly, addicts who are trying to abstain or refrain from the drug use may also internally impede the behaviour, for example a smoker might be trying to cut down on the number of cigarettes that he or she smoke each day. If the normal drug-use behaviour is impeded, a non-automatic, effortful cognitive process is elicited and this causes the craving. For example, an alcoholic denied alcohol becomes frustrated and begins craving for alcohol and engages in cognitive problem solving and behavioural responses to try and gain access to alcohol (e.g. finding a way to get a drink).

This theory has significant implications as it accounts for the disruptive impact which cravings are observed to have on the everyday functioning of addicts. Since an individual's cognitive resources are limited, an addict faced with craving would be less capable of coping with other cognitively demanding situations. An important aspect of Tiffany's model is that the non-automatic processes that constitute craving are limited in capacity. Therefore, any concurrent task, which also demands the use of non-automatic processes, will be interfered with by the craving experience. Also, since craving represents the operation of capacity limited non-automatic cognitive processes, it functions at the cost of disruption of other activities that also demand non-automatic processes (Tiffany and Conklin, 2000).

This prediction of the model has since been supported by a number of studies assessing the extent to which craving interferes with other concurrent cognitive activities. Cepido-Benito and Tiffany (1996) used a dual-task procedure to investigate the cognitive effort associated with cigarette craving. Craving was induced in the laboratory by having smokers vividly imagine brief scenarios that described the desire to smoke. This manipulation was reported to dramatically increase the cravings experienced by the subjects in comparison to the neutral-imagery conditions. The subjects also had to press a button each time they heard a brief tone. The results showed that imagery-induced craving disrupted performance of this simple task; in comparison to the neutral-imagery condition, smokers with imagery-induced craving took significantly longer to press the button during craving imagery. Similar demonstrations of the cognitive demands of craving have been produced in other studies with both cigarette (Sayette and Hufford, 1994) and alcohol craving (Sayette et al., 1994).

As influential as Tiffany's theory is, it fails to give a complete account of craving, as it does not really provide an account for the role of emotional and motivational aspects of craving. Tiffany argues that the model explains the lack of predictive power of craving in relapse. However, as discussed earlier, though weak, there appears to be a relationship between craving and substance use. Tiffany's model does not explain how the craving experienced brings about the drug use behaviour or why cravings are often experienced as being aversive, even though Tiffany and his colleagues have conducted research into the role of emotion as an eliciting factor (Tiffany and Drobes, 1990). Studies have also been conducted where imagery has been used to elicit craving in the laboratory (Drobes and Tiffany, 1997; Maude-Griffin and Tiffany, 1996; Tiffany and Hakenewerth, 1991). However, the model does not include imagery in its explanation of how cravings work, nor does it provide an explanation as to why imagery is so effective in the manipulation of the craving experience.

2.4 *The Elaborated-Intrusion Theory of Desire*

Kavanagh, Andrade and May (under review) provide a new alternative cognitive account of craving in the Elaborated-Intrusion Theory of Desire (EI theory). This theory regards craving as the experience of a particular cognitive activity and associated emotions, rather than an epiphenomenon. They define craving as being the "desire to engage in appetitive behaviour". This includes most of the factors that are involved with the experience, such as the thoughts and images about the activity in question as well as an awareness of the individuals' emotional and physiological states, such as withdrawal and unhappiness, anticipated pleasure or relief about the target substance or activity. The concept of desire is described by emphasising the relationship between cognition and affective factors. Most of the existing models of craving are only applicable to addictive substances like drugs and alcohol. However, it does not seem possible that we

have one system that controls our cravings for addictive substances and another for our other desires. The EI theory of desire is not only applicable to addictive substances but can also be used to explain other motivated behaviours. The key features of the model are depicted in Figure 1.

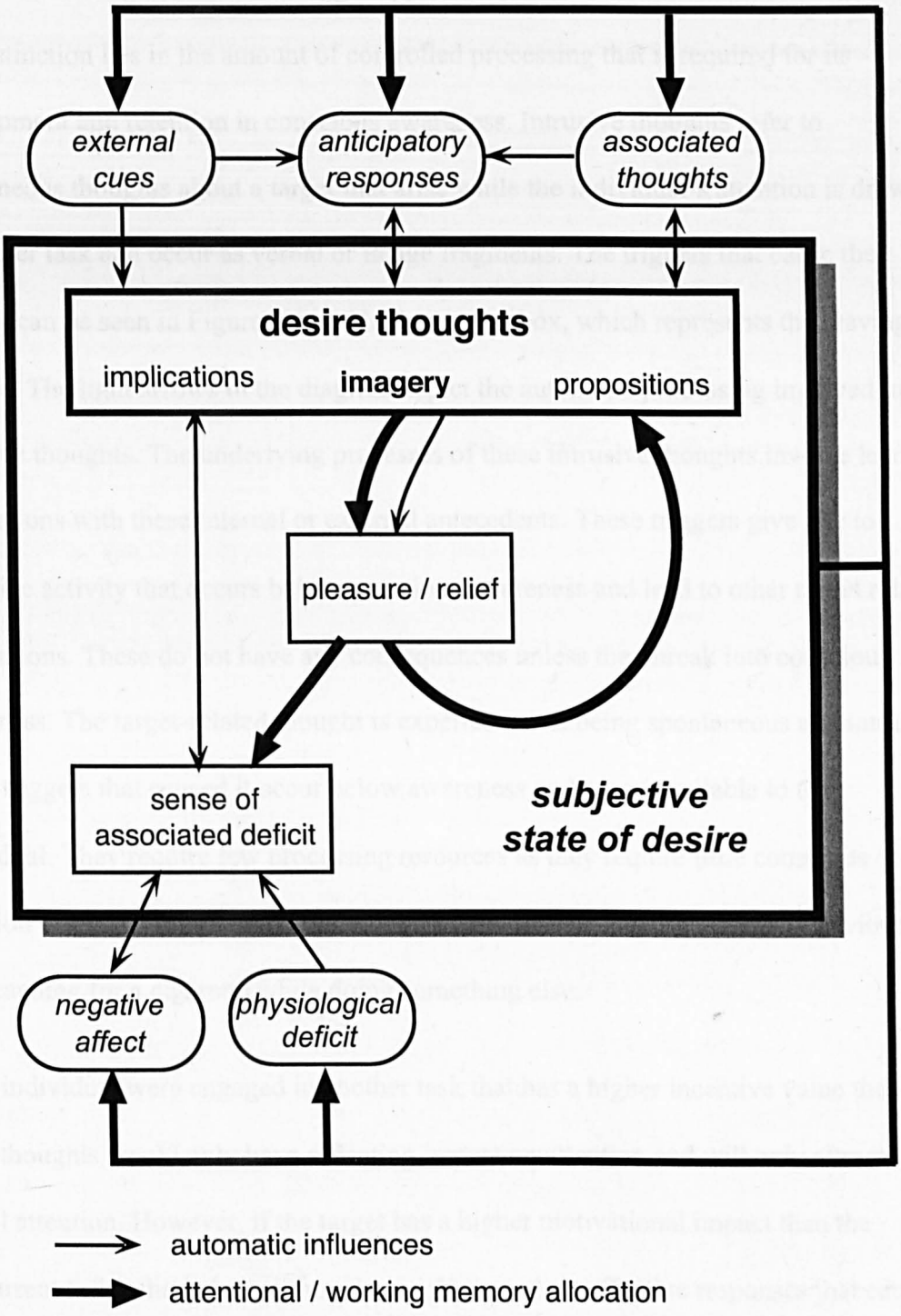

Figure 1: The Elaborated-Intrusion theory of Desire. The central box shows the experience of desire whilst the eliciting and reinforcing factors are shown around it. Light arrows depict intrusive thoughts while the dark arrows represent the elaboration.

The theory distinguishes between two types of appetitive cognitions: intrusive thoughts and elaborated cognitions. Both trigger appetitive behaviour but do so in different ways. The distinction lies in the amount of controlled processing that is required for its development and retention in conscious awareness. Intrusive thoughts refer to spontaneous thoughts about a target that arise while the individual's attention is drawn to another task and occur as verbal or image fragments. The triggers that cause the craving can be seen in Figure 1, outside the central box, which represents the craving episode. The light arrows in the diagram depict the automatic processing involved in intrusive thoughts. The underlying processes of these intrusive thoughts involve learned associations with these internal or external antecedents. These triggers give rise to cognitive activity that occurs below conscious awareness and lead to other target related associations. These do not have any consequences unless they break into conscious awareness. The target-related thought is experienced as being spontaneous and intrusive as the triggers that caused it occur below awareness and are unavailable to the individual. They require few processing resources as they require little conscious attention or mental effort. Intrusive thoughts can lead to "absent-minded" behaviour, like reaching for a cigarette while doing something else.

If the individual were engaged in another task that has a higher incentive value then these thoughts would only have a fleeting impact on attention and will only attract partial attention. However, if the target has a higher motivational impact than the concurrent tasks, the intrusive thought would then elicit affective responses that capture focal awareness. Since the thought contains information that is related to the use of the target substance, the individual experiences positive sensations of reward or relief, as if they were using the substance. This brings about the second thought processes of cognitive elaboration (dark arrows in Figure 1), where the individual enriches the target-

related thoughts by the formation of more associations. This elaboration is responsible for the interference with other cognitive tasks.

The further associations made then feed into the elaborative process and the desire is maintained in focal awareness. Elaborated desire thoughts involve consciously directed activity and result from the search for relevant information and the retention and manipulation of the results of the search in working memory. The search could either be internal in that target related cognitions and the individual's current physiological state increases in salience, or it could be external in that specifically relevant environmental cues increase in salience. The search would involve the use of information held in long-term memory; this could be sensory information (the smell of a cigarette), generic information (the shape of a cigarette), specific personal experience (how nice a cigarette would be to calm a stressful situation) or relevant action schemata (lighting a cigarette). The subsequent behavioural response will therefore be more a result of the process of cognitive elaboration rather than the initiating cue.

According to the EI theory, affective responses play an important role in the initiation and elaboration of desire. Initially the intrusive thought brings about a pleasant state linked to reward processes but, on elaboration, the individual focuses on the state of deprivation. In a normal situation the individual would engage in the substance use behaviour and seek out the substance for consumption. However, if the individual is trying to cut down on consumption or the situation does not allow consumption, and the desire is not fulfilled for either external or internal reasons, the individual's initial state of pleasure will become an aversive state of deficit awareness. Thus, the craving, which at first is pleasurable, will, if not fulfilled, lead to a negative affective response. The predominant emotional reaction in many craving episodes is negative as the salience of

deprivation is increased. Deprivation or withdrawal has been shown to induce desire. Though physiological deficits are not thought to initiate desire directly, the awareness of a deficit state and the negative mood that is brought about induces a desire for the target or activity. The craving episode will only be terminated by the acquisition of the target or by other cognitive requirements as the individual would want to alter the negative mood state. If the target is not available at that point in time, and the other cognitive requirements are weak, the desire will remain in the individual's awareness. In contrast to theories that define craving as an epiphenomenon, the EI theory argues that craving represents a strong motivating force that is moderated by other factors (e.g. availability or other desires). Therefore, it acknowledges the causal relationship between craving and behaviour and also explains why craving does not always bring about the substance-use behaviour.

2.5 Craving and Imagery

The EI theory proposes that a key feature of the elaborative process is the development of images or fantasies about the target or experience or the effects of consumption. Images are thought to be central to the naturalistic experience of craving and are responsible for the emotional and motivational power of craving. Images about the desired substance during the elaborative process keep the desire in conscious awareness, and are then experienced by the individual as a craving episode. The effectiveness of imagery in maintaining craving comes from its effectiveness in activating emotional and motivational pathways. The elaborative processes do not just involve the development of images but may also involve semantic elaboration. Fantasies about the target substance are similar to the consummatory experience itself, so they provide a motivational power and help the individual seek out the desired substance. Images do not have to be restricted to visual content but can involve smell, taste or hearing. Even

though the theory acknowledges that desire related thoughts could be verbal (e.g. "A cup of coffee would be really nice now"), it suggests that craving is maintained by the imagery elicited by the verbal thought (e.g. the smell or taste of a cup of coffee). The imagery becomes the driving force of craving. Support for the idea that imagery triggers the emotional changes involved in craving comes from studies that link imagery and emotion (Holmes, Grey and Young, in press; Holmes and Matthews, 2004; Weinstein, Wilson, Bailey, Myles and Nutt, 1997; Witvliet, 1997). Imagining emotive memories or situations brings about physiological changes of heightened affect (Bywaters, Andrade and Turpin, 2004a; Witvliet and Vrana, 1995). The more vivid the mental images are the more emotive and arousing they can be (Bywaters, Andrade and Turpin (2004b).

Though imagery has not been included in craving theories before, many studies have shown the effectiveness of visual imagery in inducing craving in individuals (Green, Rogers and Elliman, 2000, Tiffany and Drobes, 1990). The vividness of the imagined urge induction scene has also been shown to positively correlate to the strength of induced craving (Harvey, Kemps and Tiggerman, in press). The cue-exposure paradigm provides evidence that the exposure of addicts to items or pictures associated with their drug-use can induce a state of conditioned craving (Childress et al., 1985, 1986a,b, 1987, 1988). Case studies of cue exposure techniques by Bradley and Moorey (1988) have also shown that images tend to act as a trigger, which is sufficient to provoke a craving. Imagining the place the subjects usually took their drug has also been shown to be enough to bring about imagery of drug taking which, in turn, brings about a craving.

Weinstein et al. (1997) investigated the effects of imagery of drug-taking experience on the craving ratings of opiate addicts who were undergoing detoxification. The addicts were asked to imagine and describe their craving experiences while their autonomic

measures of heart rate and arterial pressure were taken. The subjects showed a significant increase in systolic blood pressure during drug-related talk compared to neutral talking. They also showed a significant increase in systolic blood pressure during drug-related imagery when compared to neutral imagery. Similar significant increases were also seen in heart rate. The results observed in the study provide evidence that the imagery technique is powerful in eliciting craving for opiates, which supports previous studies carried out by Childress et al. (1988), suggesting that opiate-related stimuli are powerful in eliciting autonomic conditioned responses. In a study exploring the factors that make abstaining alcoholics crave alcohol, Weinstein, Lingford-Hughes, Martinez-Raga and Marshall (1998) compared the effects of inducing craving for alcohol by exposure to the sight and smell of an alcoholic beverage, imagery of craving scripts, and recall of autobiographical memories of craving. Their findings suggested that images were as effective as in vivo exposure in eliciting cravings for substances.

Tiffany and Hakenewerth (1991) showed that it was possible to generate smoking urges in the laboratory using an imagery manipulation. Smokers were asked to listen to scripts containing descriptions of a smoking situation as well as neutral scripts, which did not have any smoking content. The scripts were equated on vividness ratings and the occurrence of positive and negative affect descriptors. They were instructed to imagine vividly what they were hearing and then rate how vivid their image was as well as the intensity of their maximum urge to smoke during that trial. The results showed that the subjects reported significantly stronger urges to the urge scripts than the neutral scripts. The imagery manipulation clearly produced content-specific effects in both physiological responses and verbal reports of smoking urges. The imagery scripts that contained explicit descriptions of smoking urges elicited significantly stronger urge

reports than scripts devoid of explicit urge content. Tiffany and Drobes (1990) have also tested the imagery paradigm with similar results.

More evidence for the importance of imagery in the experience of craving comes from a study by Salkovskis and Reynolds (1994), looking at thought suppression and smoking cessation. They looked at whether the deliberate suppression of intrusive thoughts was associated with increased levels of intrusion compared to monitoring without suppression. They found that intrusive thoughts about smoking do occur frequently; subjects also reported difficulty in controlling smoking related intrusions. The research by Salkovskis and Reynolds also suggests that imagery formed an important component of craving. The subjects had to rate the intensity and frequency of smoking related thoughts and images. The most frequent and intense smoking related thoughts reported by the smokers in the study were "Images of yourself under stress, having a cigarette to help calm down or cope" and "Image of yourself in a relaxed place, enjoying a cigarette". Salkovskis and Reynolds argue that imagery is a neglected feature of the elaboration process of the craving experience. When we think about something, the propositional meaning of the thought is not what is thought to capture our attention. The thought about the desired substance is not what is important; instead the "hot cognition" is the image of the craved substance. Though it is quite possible that smoking craving involves auditory imagery like the sound of a lighter, or even the rustle of rolling papers, the evidence from Salkovskis and Reynolds, as well as studies that use imagery in inducing smoking cravings, would suggest that smoking craving involves predominantly visual imagery. However, when considering other substances or activities, different targets might involve different sensory modalities, and therefore different imagery: for example the desire to gamble may involve auditory imagery and elaboration such as hearing slot machines dispensing coins.

The EI theory and Tiffany's model of cognitive processing are similar in that they both propose that craving occurs when the individual becomes aware of some cognitive activity. The EI theory states that intrusive thoughts are triggered automatically by external or internal cues: the individual becomes aware of the thought and engages in cognitive elaboration, which maintains the craving in awareness. Tiffany's model also makes a distinction between automatic and controlled processing: drug use behaviour becomes automatised and craving occurs when the automatic behaviour is interrupted. However, Tiffany does not explain when the individual becomes aware of the interruption of a drug-use sequence: when the craving is experienced. The most notable difference between the two theories is that the EI theory goes onto explain the contents of a craving episode and introduces the role of mental imagery as part of the experience. As discussed earlier, though Tiffany uses imagery to induce craving in the laboratory, his model does not provide an explanation as to why the method is successful.

Though there is empirical support for the involvement of imagery in craving episodes, the precise role of imagery is unknown. Imagery has not been included in previous models of craving even though it has been used as a manipulation in many studies. The EI theory is a novel theory, which attempts to incorporate all the factors that have been shown to be involved in the craving experience, as well as focusing on the role of sensory imagery in desire cognition. Examining the theory and providing empirical evidence for the predictions made by it would increase our understanding of the complex processes involved in the craving phenomenon.

3 Overview

This thesis provides an exploration of the craving phenomenon and tests key predictions made by the Elaborated-Intrusion Theory of Desire. The theory supports the generality of craving as it is not just related to addictive substances but should be applicable to everyday craving and all motivated behaviours. The theory distinguishes between intrusive and elaborated thoughts and focuses on the role of visual imagery in the craving episode. The research reported in this thesis extends from questionnaire studies of the phenomenology of subjective experience of craving to laboratory experiments testing the role of imagery in craving. The final study attempts to use visual imagery as an intervention technique to help participants give up smoking.

Chapters 4 and 5: Questionnaire Studies

Chapters 4 and 5 report the preliminary stages of the research project. The initial stages of this research focused on increasing our understanding of craving by investigating the subjective experience of craving. Questionnaire 1 was used to get at-the-time responses from cravers about triggers and descriptions of their craving episodes.

Unlike most craving theories that focus on addictive substance, the EI theory acknowledges the generality of craving. The results observed in Questionnaire 1 indicated that subjective experience of desire was qualitatively similar across different target substances. Questionnaire 2, reported in chapter 5, explored this further by comparing responses between cravings for general food and drink substances and tobacco cravings in smokers. It also investigated whether addicts (smokers) differed from non-smokers in their general cravings.

Chapters 6, 7 and 8: Imagery Studies

The focus of the EI theory on visual imagery is a fairly new concept in craving studies. Previous theories have not explained the relationship between visual imagery and craving. The experiments described in these chapters tested whether craving involved visual imagery and investigated the effect of imagery manipulations on cigarette craving. Experiment 1 tested the effects of active visual and auditory imagery tasks on deprived and non-deprived smokers. Experiment 2 investigated the effects of a passive task, known to interfere with visual imagery, on smoking craving. Based on the inconsistent results observed in Experiment 2, Experiment 3 was carried out to further investigate the effects of the tasks on craving in smokers.

Chapter 9: Intervention Study

The final experiment tested the effectiveness of the visual imagery task as a management technique in smokers. Since blocking visual imagery was shown to reduce smoking craving in the laboratory, this study investigated whether the task could be used to influence smoking behaviour outside the laboratory setting. The results of this experiment would be beneficial in the development of coping strategies for people who are trying to give up their addictions.

A summary of the results of all the studies along with their limitations and how they may be improved is provided in chapter 10, as well as an overall discussion covering issues relating to the research as a whole.

4 Questionnaire 1: Assessing the nature of everyday craving

The methods used in the assessment of craving currently depend mainly on individual's subjective reports of their craving experiences. Even though self-reported measures are used in craving research, researchers have not developed a highly reliable and sensitive questionnaire of craving (Tiffany et al, 2000). The lack of, or weak, association between craving and behaviour may be owing to the lack of an accurate measure of craving. Until recently, most researchers have used unvalidated, single-item questionnaires when asking about craving (e.g. Paille et al., 1995; O'Malley et al, 1992, 1995). Though these questionnaires are quick and easy to use, a complex phenomenon such as craving cannot be assessed using a single item (Tiffany et al., 2000). More recently, multi-item questionnaires have been used to gain more accurate measures of craving levels and to examine the multi-dimensional nature of craving. An example of these is the Questionnaire of Smoking Urges (QSU - Tiffany and Drobes, 1991), which has provided a model for the development of the Cocaine Craving Questionnaire (Tiffany, Singleton, Haertzen and Henningfield, 1993), the Heroin Craving Questionnaire (Tiffany, Field, Singleton, Haertzen and Henningfield, 1998) and alcohol questionnaires (Bohn, Krahn, Staelher, 1995; Love, James and Willner, 1998; Singleton et al., 1995). Furthermore, brief forms of these questionnaires have also been shown to give reliable and sensitive measures of general craving. Tiffany and colleagues use a brief 10-item form of the QSU in their laboratory studies (Tiffany et al, 2000).

These questionnaires represent useful instruments to evaluate and provide accurate measures of smoking urges. However, retrospective questionnaires could be subject to bias and maybe more descriptive of how the individual thinks a craving episode ought to be like. Furthermore, questionnaires that are filled out in the laboratory may not be a reliable representation of individuals' cravings when they are in their normal

environment. To gain an accurate measure and insight into a person's craving, the questionnaires should be filled out at the time the craving is being experienced.

Self-report measures are currently used in research and are thought to be a reliable indicator of an individual's craving experience. However, given the subjective nature of the phenomenon, measures that rely on retrospective recall may suffer from recall error bias. Autobiographical memory is subject to significant bias (Shiffman, Hickcox et al., 1997) and an individual's description of a past craving episode would be influenced by the individual's own knowledge and opinions of craving. Memory is also often influenced by the individual's current state. The study and treatment of addiction relapse relies heavily on the recall of a specific event. Shiffman, Hufford et al. (1997) tested the accuracy of recall in a group of 127 smokers when relying on retrospective recall of their smoking lapses. They found that participants tended to overestimate their negative affect and the number of cigarettes they smoked during the lapses; Shiffman and colleagues (1996) suggest caution when using recall in research and intervention and often use palm-held computers in their research. Recall errors occur in all studies that rely on respondent's self-report. Recall bias has also been shown to occur in the assessment of pain in children. When comparing a retrospective headache questionnaire with a prospective headache diary, recall errors were observed in the responses on the retrospective questionnaire. The intensity and duration of headaches were overestimated on the questionnaire. Discrepancies between diaries and retrospective questionnaires have also been shown in studies of sexual behaviour. The questionnaire data yield consistently higher average estimates than the diary (Coxon, 1999). When recalling past experience, people have a tendency to remember the peaks of intensity or they are influenced by how they are currently feeling at that point of time. Recall errors can be caused by a number of factors. The length of time between the experience and the

completion of the questionnaire, interference from other events that have occurred after the experience, the salience of the event, the current mood state of the respondent and the stereotypes that the individual might have regarding the event would all influence the individual's self report. When using questionnaires to collect information, researchers have no assurance that the responses are being written at the appropriate time. For example, in a craving study, it is impossible to know whether the questionnaire is being completed at the time of craving or whether the individual puts off the completion of the questionnaire for later in the day when they would then be relying on their recall of how they felt during the craving episode.

Most of the questionnaires used in research are retrospective (e.g. Obsessive-Compulsive Drinking Scale OCDS– Anton et al., 1995; the Lübeck Craving-Risk-Relapse questionnaire (LCRR– Veltrup, 1994) as cited in Potgieter, Deckers and Geerlings, 1999). Craving questionnaires involve questions about the intensity of desire, mood, the presence of cues and coping skills and performance. The recall accuracy of these variables however, is known to be quite poor. Thus, recall errors and bias can systematically create false associations and the weak relationship between craving and relapse could be due to inaccurate measures of craving. To gain an accurate representation of a craving episode that is not subject to bias and recall errors, questionnaires should be filled out at the time of craving.

This study looks at the craving phenomenon using a simple questionnaire, which asks what brings on a craving episode, and what the episode feels like (see Appendix A). The respondents are instructed to keep the questionnaire with them and fill it out when they experience a craving. This would take away bias from retrospective recall, because the responses made would be made at the time of craving and are also made in the

individual's natural environment. The questionnaire is short and simple to fill out and can be done easily before the individual gives into the craving.

The questionnaire was generated to discover what individuals attribute the cause of their craving episode to, as well as what the craving episode was like. Existing models suggest that cognitive processing, somatic sensations and behavioural responses elicited by drinkers in current and past contexts evoke craving. The EI theory suggests that the onset of craving would be experienced as being spontaneous. The theory also suggests that visual imagery is a crucial aspect of craving in smoking; the questionnaire includes statements involving visual imagery in describing the craving episode itself as well as describing what brought it on. In addition, there are also statements that incorporate auditory and taste imagery as well as mood and expectancy. The statements included in the questionnaire incorporated the antecedents identified by both the EI theory and Tiffany's model. There were twelve potential causes and the respondents were asked to rate how well each trigger statement related to their craving episode. Similarly, descriptive statements that either one or both models suggest to be important to the craving experience were also included in the questionnaire. The results obtained from the study should provide an insight into the subjective aspects of a craving episode. This would be beneficial in designing further studies to test craving as well as giving information on how to control craving, and would lead to improved evaluations of hypotheses regarding craving.

4.1 Method

The questionnaire was included in the introduction packs sent out by the University of Sheffield to 1500 new students in August 2002. They were also supplied with a postage paid envelope in which to send the questionnaire back.

Instructions were given at the top of the questionnaire. To ensure the definition, instructions and statements were clearly understood and representative of the craving experience the questionnaire was first presented to a pilot group of 20 university students, who were asked to complete the questionnaire and to add any statements they thought described their experiences with craving and also to delete any statements they felt did not really apply to the experience. The statement regarding boredom was included in the questionnaire after this process, and the final version of the instructions were as follows:

"Everyone knows what a craving is – it is an intense desire for something like food, or tobacco, or a drink of some kind, which at one time or another we have all experienced. Despite this, the causes of craving and the ways it influences our behaviour are not well understood. You can help us to discover more about craving by completing this brief questionnaire and returning it to us in the envelope provided. All replies are entirely anonymous, and we have no way of identifying the people who have returned the questionnaires. We hope that the results of this survey will help us improve the support for people who are trying to cut down on some substance. Please keep this questionnaire nearby until you find that you are craving something, and then fill it out as accurately as you can."

The respondents were asked to keep the questionnaire in close proximity until they experienced a craving for something. There was a restriction on the categories that the craved substance could belong to. The categories named on the questionnaire were: Food, Alcoholic Drink, Non-Alcoholic Drink, and Tobacco. Respondents were asked to circle one of these categories and then to specify their craved substance. They then rated the strength of their craving on a Likert scale of 1 (*very slight*) to 10 (*overwhelming*).

The questionnaire then dealt with the triggers of craving. There were twelve statements suggesting different triggers (Table 1) and the subjects used a Likert scale of 1(*not at all*) to 5(*definitely*) and circled the number depending on how much the statement applied to them[1].

Trigger Statement	Shortened Name
Other things I was thinking about it reminded me of it	Thoughts
I felt stressed / anxious / sad	Negative mood
I pictured myself having it	Visual imagery
I suddenly thought about it	Intrusive
I felt happy	Happy
I saw / heard / smelt it	External cue
I had nothing else to do / I was bored	Bored
I always have it at that time / place	Habit
I imagined the smell / taste of it	Olfactory imagery
I felt hungry / thirsty / physical discomfort.	Physiological
I was really busy.	Busy
I imagined the sound of myself having it.	Auditory Imagery

Table 1: Trigger statements for craving with their shortened names used in report of data analysis.

[1] This questionnaire is not a psychometric test and so was not piloted for reliability and validity. The questions assess people's subjective experience, which may differ from one craving episode to another, rather than an underlying trait.

The next section similarly asked them to rate the descriptive statements (Table 2).

Descriptive Statement	Shortened Name
I wanted it because I am hungry/thirsty/tired/ in physical discomfort	Physiological
I am imagining the taste of it	Olfactory imagery
I have it with me right now	Availability
I am visualising it	Visual Imagery
I am thinking of how much better I will feel after I have had it.	Feel better
I am trying to resist having it	Resistance
I can hear myself having it	Auditory
Having it would feel very comforting right now	Comfort
If I don't think about it, my craving will go away	Avoidance
I would feel more relaxed if I had it	Relaxed

Table 2: Statements used to describe craving with their shortened names used in report of data analysis.

There was also space allocated on the questionnaire for subjects to describe their own craving experience if they felt the statements given did not describe their individual experience of the craving. Finally, they were asked if they had given in to their craving, or were planning to give in to their craving and whether they were currently trying to cut down their consumption of the craved substance.

4.2 Results

Three hundred and sixty one completed questionnaires were returned by the cut off date of 20th September 2002, four weeks after the initial mailing (one neglected to describe the craved substance or its category and thus could not be analysed), which gave a response rate of 24%. The median age of the 353 who reported their date of birth was 19 years 8 months with a range from 14 years 6 months to 55 years 4 months. Replies were received from 155 males and 201 females (five did not specify their sex).

Seven people reported a craving involving food and one of the two drink categories, and for the purposes of classification the first substance specified was used to determine their primary craving (five mentioning the food first, two a soft drink). Following this, food cravings were reported by 219 (61%) people, tobacco cravings by 60 (17%), soft drink cravings by 59 (16%) and alcoholic drink cravings by 23 (6%). Inspecting the specific substance that was reported further broke down the food-craving category. This allowed the identification of sub-groups of cravings for chocolate (76 people – 21%) and snacks (75 people – 21%), with the remaining 68 people reporting cravings for main meals, breakfasts, or not specifying any particular substance (19%). These were put into a general food-craving category, which resulted in a total of six categories of craved substance.

The strength of craving scores (question 2 on the questionnaire), reported by 306 people, did not differ significantly between these craved substance groups ($F(5,300) = 0.50$, $MSE = 4.14$, ns), with an overall mean of 5.5 and a standard deviation of 2.0 (every point on the ten point scale was used; the mode was 7, used by 81 people, with another 59 using 4, which gave a somewhat bimodal distribution). This indicates that there are no differences between the substance groups; namely that the tobacco and

alcohol groups do not differ from the other groups, despite the fact that cigarette smoking involves a significant physical dependence. This suggests that, within our sample, everyday craving for substances other than the usual addictive substances like cigarettes and alcohol are similar in intensity to the everyday experience of smoking.

Of the twelve trigger statements, eight showed a strongly skewed distribution with a modal response of 1 (*not at all*). These include negative and positive affect statements (I felt stressed/anxious/sad; I felt happy), internal and external cues (Other things I was thinking about it reminded me of it; I saw/heard/smelled it) as well as the statements "I was really busy" and "I always have it at that time/place". The statement about auditory imagery (I imagined the sound of myself having it) also received low ratings with 85% of the sample selecting "not at all".

The four triggers (Table 3) that were thought to have caused craving were those dealing with intrusive thoughts (I suddenly thought about it), which received high ratings between 3 and 5 by 70% of the sample; olfactory imagery (I imagined the smell/taste of it; 65%), physiological sensations (I want it because I am tired/uncomfortable; 63%) and visual imagery (I am picturing myself having it; 60%).

The statement "I had nothing else to do/I was bored" also received a modal response of 1(*not at all*), but 52% of the sample also gave it sufficiently higher ratings between 3 and 5 to achieve a mean of 2.1 on the five point scale. This shows that few of the potential triggers are actually recognised as such by the respondents in this sample.

	Mean rating	%age respondents rating (1=not at all; 5=definitely)				
		1	2	3	4	5
What triggered this craving						
I suddenly thought about it	3.2	15	14	25	**26**	19
I felt hungry/thirsty/ tired / physical discomfort	3.2	23	13	15	17	**31**
I imagined the smell / taste of it	3.1	22	14	20	**25**	20
I pictured myself having it	2.8	27	14	**26**	19	14
I had nothing else to do / I was bored	2.6	**36**	12	21	18	13
I saw / heard / smelt it	2.1	**61**	5	8	14	12
Other things I was thinking about reminded me of it	2.0	**51**	19	13	12	5
I felt stressed / anxious / sad	1.9	**59**	13	14	9	5
I always have it at that time/place	1.9	**59**	13	12	8	9
I felt happy	1.8	**55**	19	15	8	3
I was really busy	1.3	**79**	11	6	3	1
I imagined the sound of myself having it	1.3	**85**	6	6	3	1
Descriptions of craving episode						
I wanted it because I am hungry/thirsty/tired/in physical discomfort	3.3	24	8	17	16	**34**
Having it would feel very comforting right now	3.1	18	14	**25**	24	20
I am thinking of how much better I will feel after I have had it	3.1	18	15	22	**25**	20
I am imagining the taste of it	3.1	23	12	19	**28**	18
I would feel more relaxed if I had it	3.0	22	14	**26**	21	17
I am visualising it	2.9	23	15	**24**	23	15
If I don't think about it, my craving will go away	2.7	**26**	21	22	15	16
I am trying to resist having it	2.5	**41**	14	16	13	17
I have it with me right now	2.0	**60**	10	10	7	12
I can hear myself having it	1.4	**78**	13	5	2	2

Table 3: Respondents' acceptance of potential triggers and descriptive statements as characterising their craving episode sorted by mean rating. Ns per row range between 345 and 356; percentages may not sum to 100 due to rounding. Mode for each statement represented in bold.

Since it was not possible to assume a normal distribution for the responses to the questionnaire (as seen in Table 3), Chi-Square tests were carried out for each scale to detect any contingencies between the scale responses and craved substance. Of the four statements that were regarded as triggers for the craving episodes, ratings for the visual imagery and intrusive thoughts did not differ according to craved substances (visual imagery: $\chi 2$ (20, N = 347)=21.10, ns; intrusive thoughts: $\chi 2$ (20, N = 348) =20.01, ns). Intrusive thoughts received high ratings (between 3 and 5) from 50% or more of respondents in each substance group (see Figure 2). Fifty-two percent of the alcohol group rated it between 3 and 5 compared to 68% of the general food, soft drink and snack cravers, 75% of the chocolate group and 80% of the tobacco cravers.

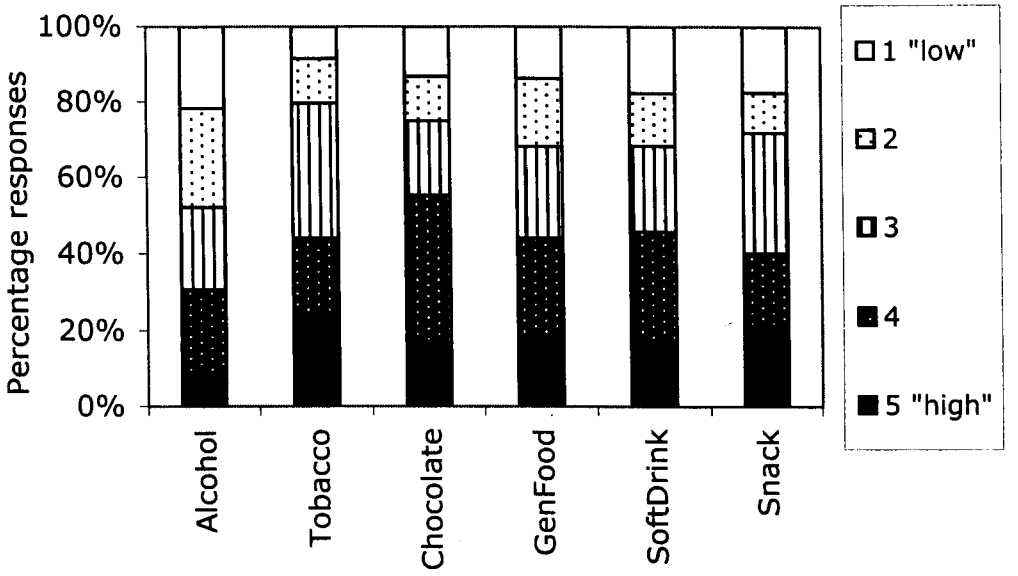

Figure 2: Ratings for intrusive thoughts as a trigger for respondents' craving episode, divided by substance group.

Although 17% to 35% of the sample rated visual imagery as "not at all" being a trigger for their craving (see Figure 3), the statement also received sufficient higher ratings from all the substance groups to reach a mean of 2.8. Around 50% of each group gave this statement a rating between 3 and 5.

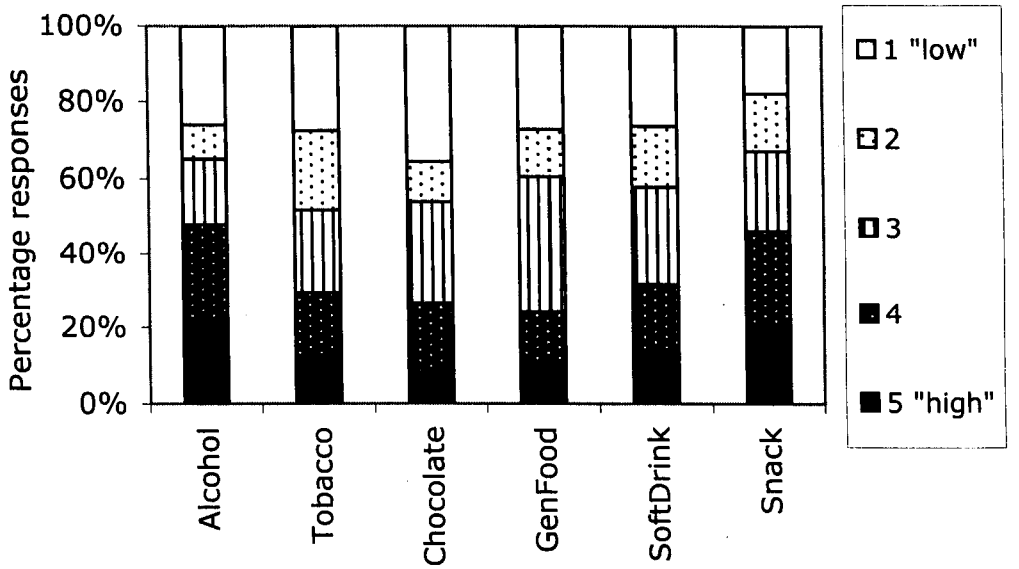

Figure 3: Ratings for visual imagery as a trigger for respondents' craving episode, divided by substance group.

The ratings for olfactory imagery and physiological sensations statements did differ according to craved substances (Olfactory imagery: $\chi 2$ (20, N = 347) = 37.86, $p < 0.001$; Physiological: $\chi 2$ (20, N = 349) = 76.96, $p<0.0001$). The tobacco cravers differed from the other substance groups in their responses to olfactory imagery statement (Figure 4), in that they were less likely to see olfactory imagery as a trigger for their craving. Only 39% of tobacco cravers gave it a rating between 3 and 5, compared to 57% of alcohol cravers and between 65% and 75% of the other groups.

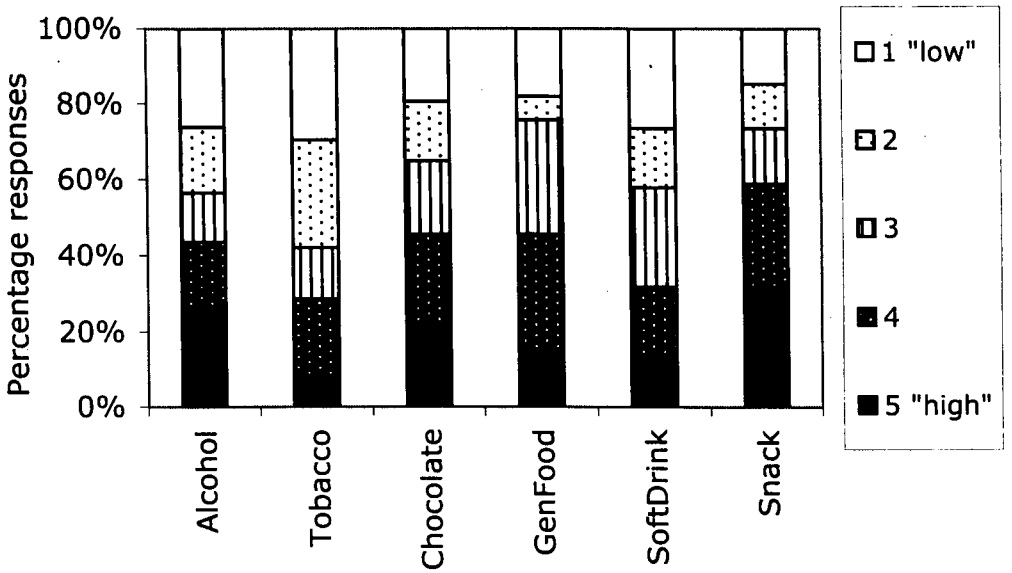

Figure 4: Ratings of olfactory imagery as a trigger for respondents' craving episode, divided by substance group.

The physiological statement (I felt hungry/ thirsty/ tired/ physical discomfort) trigger (Figure 5) was not rated very highly by the tobacco and alcohol groups. Almost 50% of the tobacco group gave it a rating of 1 – not at all descriptive of their craving. Only 30% of tobacco cravers gave it a rating between 3 and 5, compared to 48% of alcohol cravers and by 61% and 86% of the other groups. However, over 50% of the soft drink cravers gave this a top rating of 5.

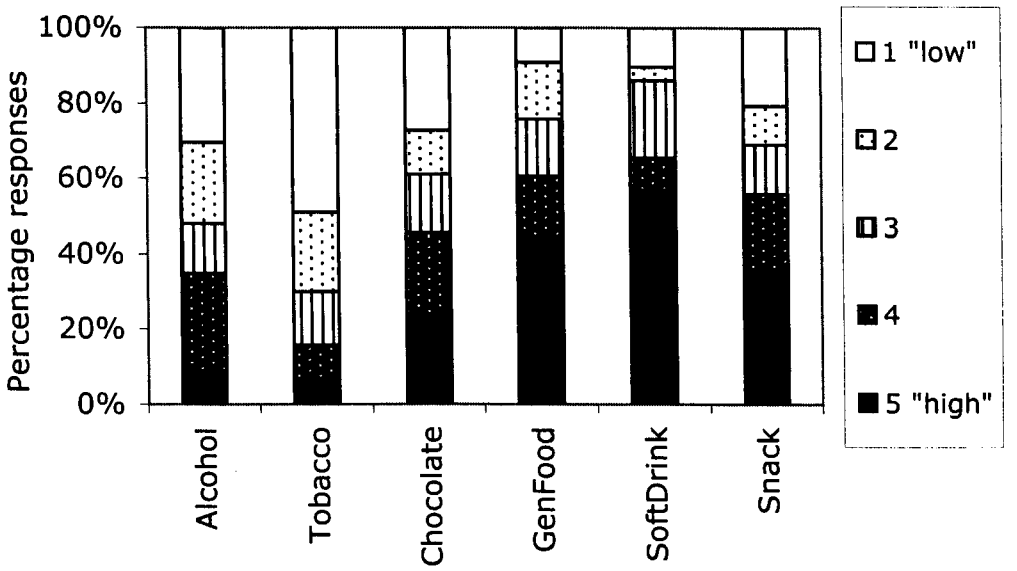

Figure 5: Ratings for physiological sensations as a trigger for respondents' craving episode, divided by substance group.

The statements describing cravings received higher ratings overall than the trigger statements. Three of the statements had a modal response of 1 (*not at all*), two of which had more than half the sample rating it as not being at all descriptive of their craving episode: "I have it with me right now" and "I can hear myself having it". The statement "I am trying to resist having it" also had a modal response of 1(*not at all*) but also had sufficiently higher ratings to produce a mean of 2.5 on the five-point scale.

The description that received the highest ratings (see Table 3) was the one dealing with physiological sensations (I wanted it because I am hungry/thirsty/tired/in physical discomfort). Other statements that were rated highly involved aspects of relief ("Having it would feel very comforting right now" and "I am thinking of how much better I will feel after I have had it").

The statement concerning auditory imagery again received low ratings, with 78% rating it as not at all being descriptive of their craving episode. In comparison, 62% of the sample rated themselves as "visualising it" using ratings between 3 and 5 and 65% of the sample rated themselves as "imagining the taste of it". Thus, auditory imagery does not seem to play a role in the craving experience, while both triggers and descriptions are often attributed to both olfactory and visual imagery.

The results obtained from the Chi-Square tests carried out on the description statements showed that there was no difference across the food substance groups for four of the descriptive statements. These included "I am imagining the taste of it", "I can hear myself having it", "Having it would be very comforting right now", "If I don't think about it my craving will go away" (all $\chi 2 < 27.33$, df = 20, ns; critical value at df = 20 = 31.41).

The other statements appeared to depend on the substance being craved. In comparison to the other substance groups, the physiological sensations descriptive statement (Figure 6) was rated as being not at all descriptive of their cravings by 58% of the tobacco and 39% of the alcohol cravers. This statement received high ratings from the other substance groups, with 53% of the soft drink cravers and 48% of the general food cravers giving it a top rating of 5. Forty percent of the snack group also gave it a rating of 5 while the 69% of the chocolate cravers rated it between 3 and 5 ($\chi 2$ (20, N =346) = 82.10, $p<0.001$).

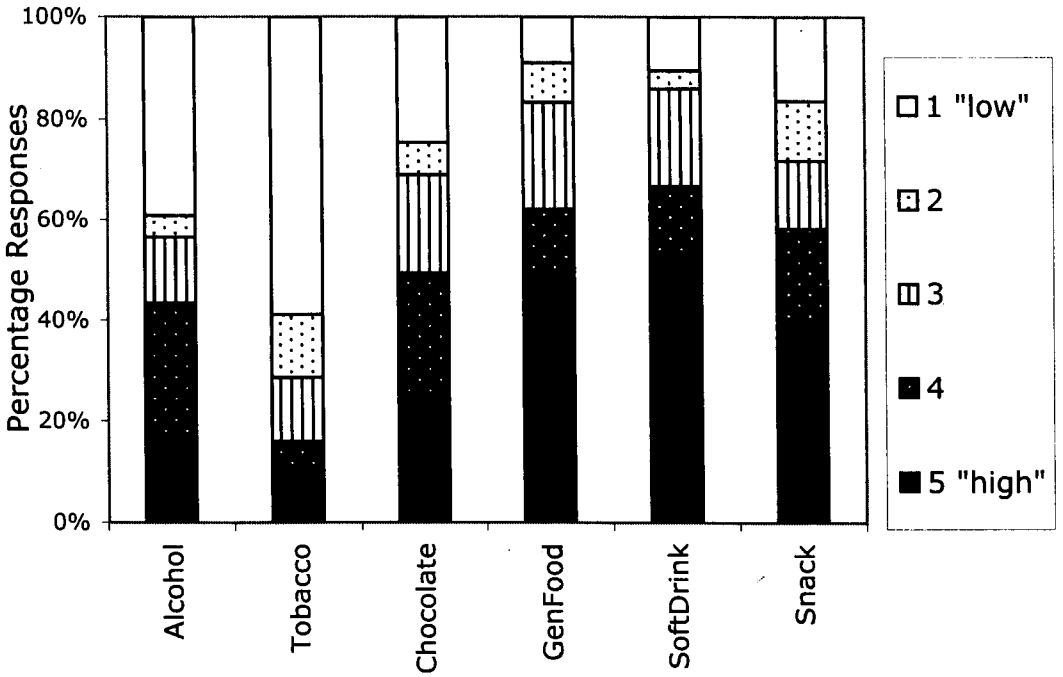

Figure 6: Ratings of physiological sensations as descriptive of respondents' craving episode, divided by substance groups.

The statement that appears to be most important for tobacco and alcohol cravers was "I would feel more relaxed if I had it" ($\chi 2$ (20, N = 356) = 41.74, $p<0.005$). This statement was rated between 3 and 5 by 86% of the alcohol cravers, with 34% of the alcohol cravers giving it a top rating of 5. Similarly, 84% of the tobacco cravers (Figure 7) rated the statement between 3 and 5 with 31% giving it a top rating. These two groups clearly have positive expectations about the effects of their craved substances. The soft drink cravers also gave this statement a high rating: 69% of the group gave it rated it between 3 and 5.

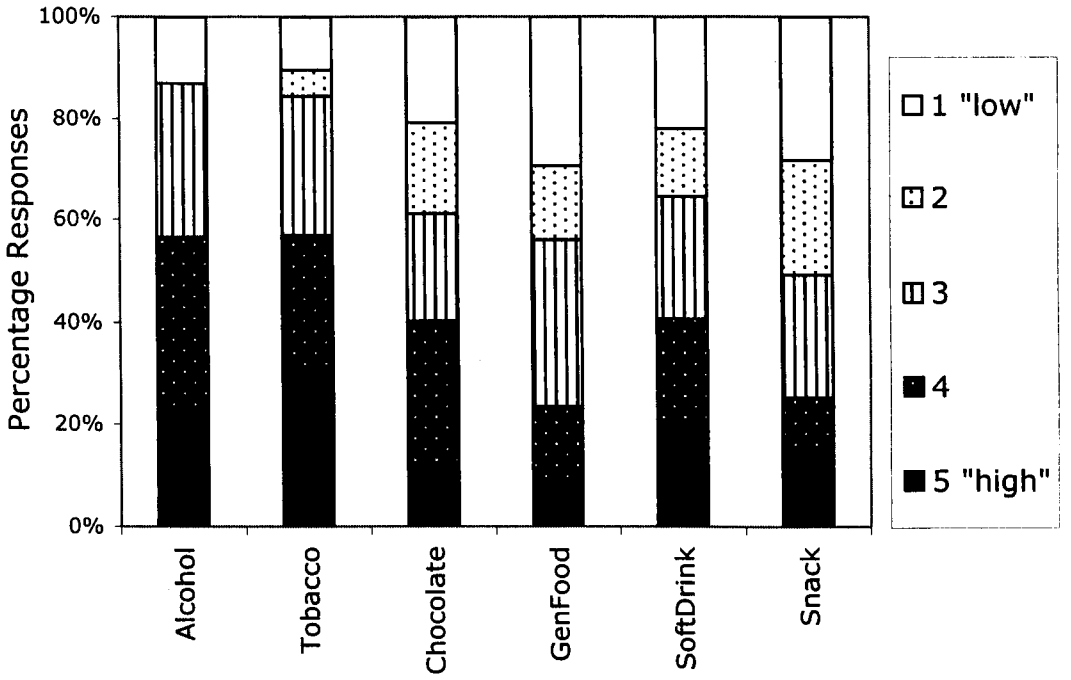

Figure 7: Ratings for relaxed statement as a descriptive of respondents' craving episode, divided by substance group.

The tobacco group also gave the statement "I have it with me right now" high ratings (Figure 8). Fifty-two percent gave it a rating between 3 and 5, with 28% of them giving it a top rating of 5. The other groups rated this statement as "not at all" descriptive of their craving episode ($\chi 2$ (20, N = 354) = 40.74, $p<0.005$). More than 50% of the other substance groups gave it a rating of 1; being not at all descriptive of their cravings (Chocolate 53%; Soft drink 59%, Alcohol and General food 65% and Snack 76%).

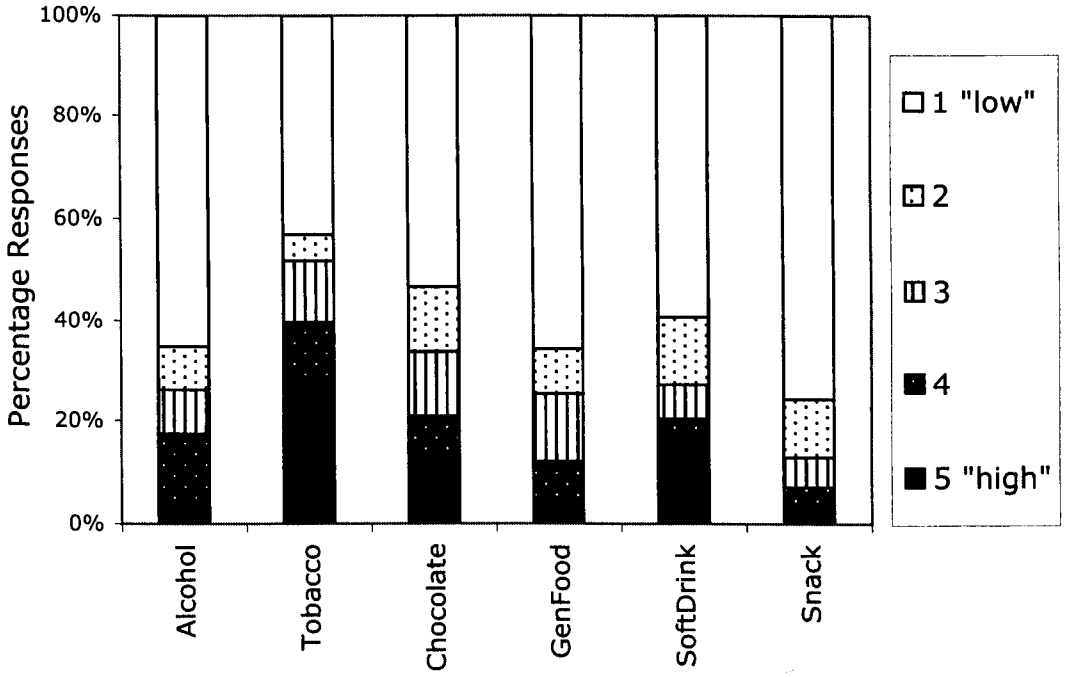

Figure 8: Ratings of availability statement as descriptive of respondents' craving episode, divided by substance group.

Seventy-three percent of the chocolate cravers and 66% of the tobacco cravers also rated the statement "I am trying to resist having it" fairly high (between 3 and 5) in comparison to between 7% and 48% of the other groups ($\chi 2$ (20, N = 355) = 85.73, $p<0.001$). Most of the other groups rated this statement as not at all being descriptive of their cravings (see Figure 9 - Snack 39%; General foods 49%; Alcohol 52%; Soft drink 76%).

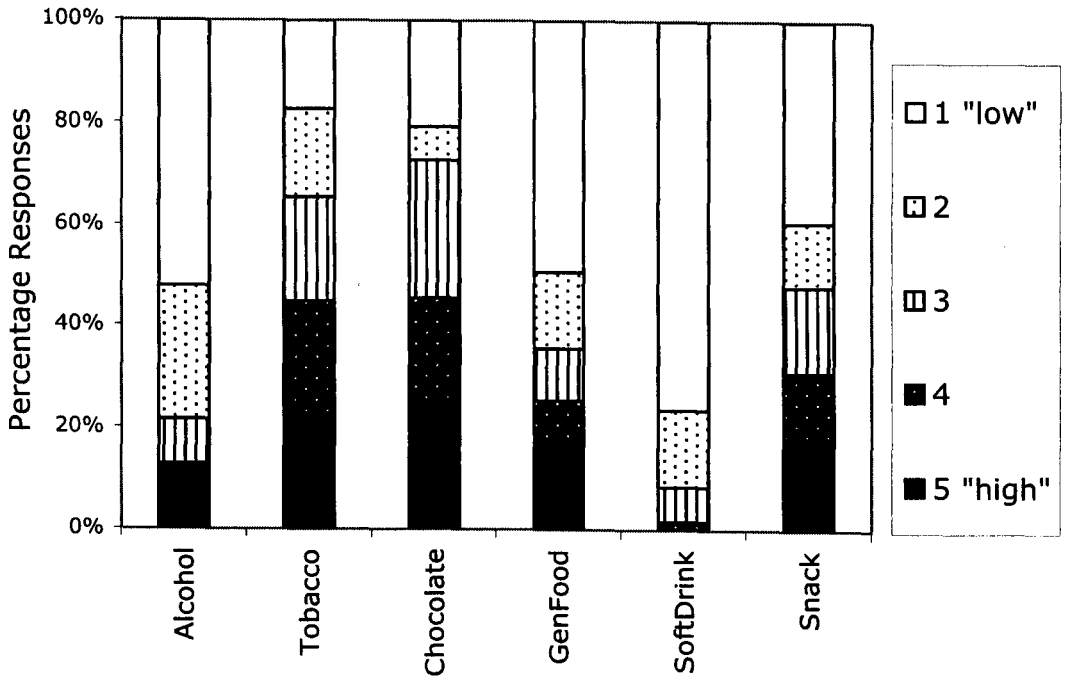

Figure 9: Ratings for resistance as descriptive of respondents' craving episode, divided by substance group.

The soft drink group differed from the other groups in their ratings to the statement "I am thinking of how much better I will feel after having it" ($\chi 2$ (20, N = 356) =35.29, $p<0.05$). Though this was given high ratings by all the food substance groups, about 34% of the soft drink cravers gave it a high rating of 5, and only about 6% rated it as not at all descriptive of their craving. This statement appears to be particularly descriptive of cravings for soft drinks (Figure 10).

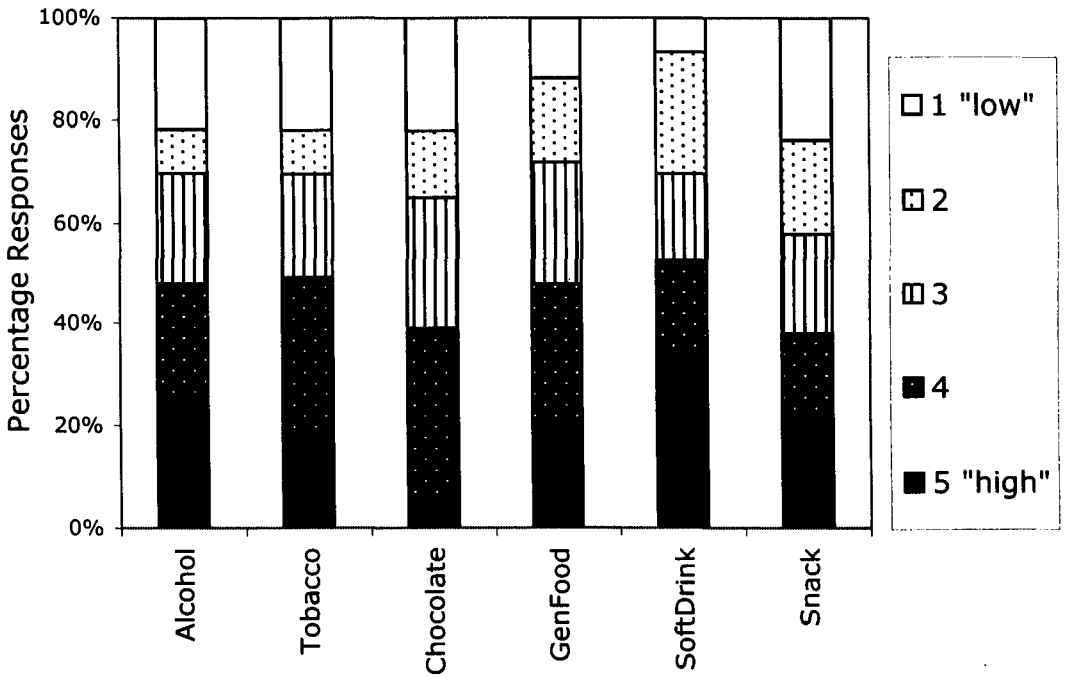

Figure 10: Ratings for feel better statement as descriptive of respondents' craving episode, divided by substance group.

The only imagery description that differed across the substance groups was the one about visual imagery ($\chi 2$ (20, N = 355) = 32.06, $p<0.05$). This received high ratings from all the groups (between 53% and 68% of all cravers rated it between 3 and 5). Thirty percent of the alcohol cravers gave it a top rating of 5 as did 20% of the soft drink cravers and 22% of the snack cravers (Figure 11). Since it has received ratings from all the groups, visual imagery appears to be involved in everyday craving. The difference within the groups seems to lie in the comparative strength of the image rather than the presence or absence of the visual imagery itself. At least 37% of the tobacco group gave this statement a rating of 3, compared to between 16% and 25% of the other groups.

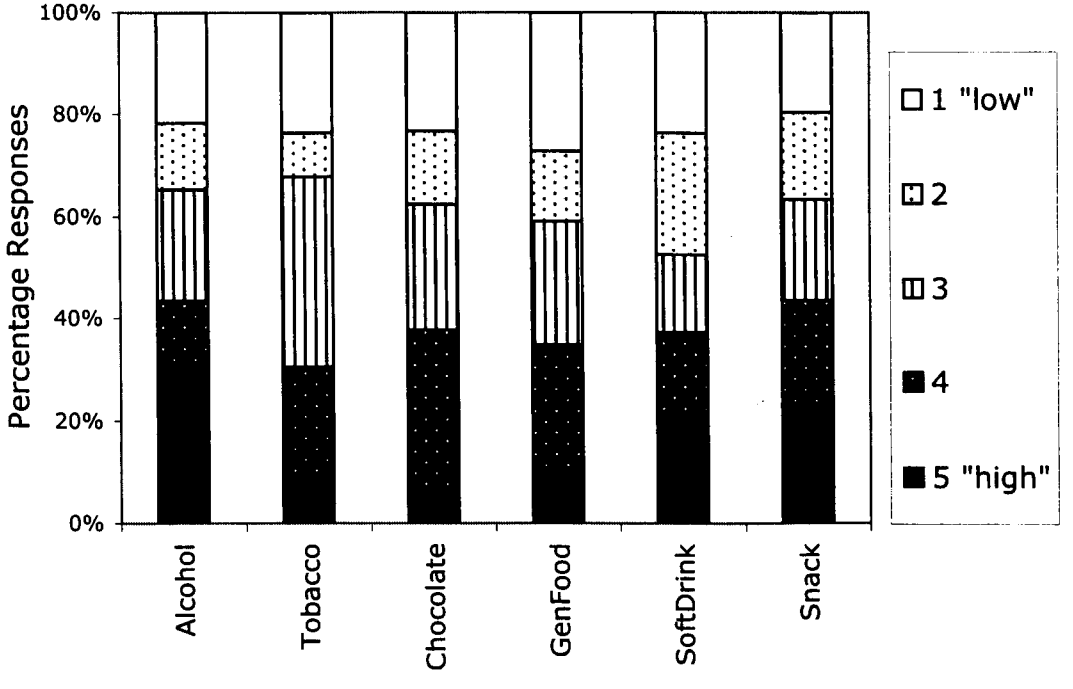

Figure 11: Ratings of visual imagery as descriptive of respondents' craving episodes, divided by substance group.

When looking at the responses to the questions about giving in to their craving and cutting down on their consumption of their craved substances, the only groups that were trying to cut down on their consumption were the tobacco and chocolate cravers; these were also the two groups that were trying to resist their cravings. Although 78% of the tobacco cravers and 73% of the chocolate cravers were trying to cut down on their consumption, 73% of the tobacco cravers and 51% of the chocolate cravers had already given into their cravings. Furthermore, approximately 37% of those who had not yet given into their tobacco or chocolate cravings were planning on giving in to their cravings.

4.3 Discussion

The data obtained on the strength of craving ratings did not show any differences across substance groups. Even though usual levels of cigarette smoking are known to involve significant physical dependence and craving, alcohol and tobacco cravings in this sample were not significantly different to the other cravings. This would suggest that the sample is not really a very substance-dependent sample, but more representative of everyday cravings experienced by a normal population. It can also be assumed that everyday craving for substances, that are not usually addictive, are similar in intensity to those that are experienced for addictive substances such as cigarettes.

The results from the analysis carried out on the trigger statements show that the respondents do not seem to be aware of what brings about their craving. They do not attribute the occurrence of the craving to anything in the environment or to the moods they are experiencing. The craving is regarded as being spontaneous and sudden, supporting the idea of intrusive thoughts suggested by the EI theory. The spontaneous nature is probably because the real triggers would have been acting beneath awareness,

so though the craving itself is in awareness, the person would not be aware of what brought about the craving.

Other statements that were regarded as triggers for cravings were the statements that included physiological sensations (I felt hungry/thirsty/physical discomfort) and the statement about olfactory (I imagined the smell/taste of it) and visual (I pictured myself having it) imagery. Auditory imagery received the lowest ratings and does not seem to be associated with craving at all. Another statement that received high ratings was "I had nothing else to do/I was bored", which was rated between 3 and 5 by over half the sample. Though these statements are identified by the respondents as triggers for their craving episodes, the craving would have to be caused by something, an external cue or a mood state, which would be the actual triggers for the craving. However, since these triggers are acting below awareness, the individual is unable to attribute the craving episode to anything and describes it as being spontaneous. The trigger statements that they rate highly can be assumed to be the intrusive aspects of these thoughts; for example: they suddenly think about their desired substance and their thoughts could contain visual imagery.

When looking at trigger statement responses across substances, tobacco and alcohol cravers differed from the others. Olfactory imagery received high ratings from most substance groups, but most of the tobacco cravers did not rate this as being a trigger for their cravings. Physiological sensations received high responses from all substance groups except the tobacco and alcohol cravers. This could be because the words used in the statement do not really apply to tobacco and alcohol craving (I felt hungry/thirsty/tired/physical discomfort), whereas they are specific to hunger and thirst. The statements would be more applicable to a food craving or a craving for a soft drink:

over 50% of the soft drink cravers gave this statement a top rating of 5. There does not seem to be a specific word, similar to hunger or thirst, to describe a craving for tobacco or alcohol.

Comparison of the imagery statements showed that the respondents did not consider auditory imagery a trigger; this statement received the lowest mean response ratings from the sample whilst olfactory and visual imagery received higher ratings. There were no differences between the responses across the groups for the visual imagery statement. All the groups appeared to think it quite important as a trigger for their craving.

The descriptive statements appeared to be generally applicable to the cravings as they received higher ratings than the trigger statements. The sample were able to describe their cravings better than identifying the triggers or cause of their craving. The statements that seemed most descriptive of the cravings were the one about physiological sensations (I was hungry/thirsty/in physical discomfort) and statements about expectancies (Having it would be very comforting right now/ I am thinking of how much better I will feel after I have had it/ I would feel more relaxed if I had it). Auditory imagery does not seem to play a role in the craving episode while visual imagery and olfactory imagery do appear to be involved with everyday craving.

Ratings of some of the statements appear to depend on the substance being craved: the results suggest that physiological sensations are not as important to tobacco and alcohol cravers as they are to the other substance groups. Again, this could be due to the fact that the words used in the statement would be more applicable to food and soft drink cravings. The expectancy statements appear to be important to the tobacco and alcohol groups, as these cravers appear to have positive expectancies regarding their craving,

more so than the other groups. However, the statement "I am thinking of how much better I will feel after I have had it" was particularly descriptive of cravings for soft drinks.

The tobacco cravers also differed in their responses to that availability statement (I have it with me right now). They were the only group to rate this statement highly with 28% giving it a top rating of 5 (*definitely)*. The resistance statement (I am trying to resist having it) was also rated between 3 and 5 by 66% of the tobacco group and also received high ratings from the chocolate group (73%), whilst the other groups did not appear to be trying to resist their cravings (only 31% of the other groups gave this statement high ratings). The tobacco cravers were more likely to carry their cigarettes around with them, but were more likely to try to resist giving in to their cravings. According to Tiffany's theory, a craving is caused by when the automatic substance use behaviour is impeded, either by internal or external factors. In this sample, 17 of the cravers gave a rating of "not at all" to the "I am trying to resist having it" statement and "definitely" to the "I have it with me right now". Tiffany's model would be unable to account for these cravings. According to the model, if the substance use behaviour is not being blocked and the individual is not trying to resist or the substance is unavailable then a craving episode should not occur. There was also no difference in the craving strength of these cravers and the rest of the sample.

The results obtained from the study tend to be in accordance with the EI theory of desire. Cravings are reported as being sudden and spontaneous and people have little insight as to what causes their craving. Once the craving is in awareness, the episode is maintained by mental imagery. So once they begin to crave, they have positive expectancies about the effect that the substance would have on their affective state, and

also maintain the episode with olfactory and visual images of their substance. Though the results suggests physiological sensations are important in the occurrence and maintenance of the craving episodes, in accordance with the Tiffany model, these sensations do not seem especially important in cravings for tobacco and alcohol, the two potentially addictive substance in the study. If Tiffany's account was correct then these two groups of cravers should also report these sensations. Thus, this aspect of the responses appears to be more consistent with the EI theory than Tiffany's model of cognitive processing.

To provide successful techniques in the treatment of addiction and control of craving, we need to have a proper understanding of the nature and determinants of a craving episode. Since the craving itself is regarded as being sudden, it would be difficult to suggest a method of preventing people from having these craving episodes. However, the data from the craving descriptions could be used to propose techniques for controlling craving, by targeting the maintenance of the craving episode. Since visual imagery appears to be important in the maintenance of tobacco and alcohol cravings, further studies that test the effectiveness of visual imagery tasks in reducing craving could be carried out in the hope of producing a reliable method of controlling craving experiences. Further research is also necessary to investigate the similarities and differences between craving for tobacco and craving for other substances. Though the craving strength did not differ according to the substance being craved, a few statements showed a difference in responses pattern according to craved substance. An improvement in our understanding of craving would contribute to the development of clinical methods of treating drug abuse and preventing relapse.

5 Questionnaire 2: Comparing everyday craving and tobacco craving

Following the identification of differences between tobacco and other substance cravings, a second questionnaire study was constructed. As well as asking non-tobacco users to report general cravings, this asked tobacco users to report their cravings for both tobacco and another substance, to see if the differences found in the first study occurred within an individual (but between substances), or between tobacco users and non-tobacco users.

The quest for uniformity among addicted people has resulted in the idea of an "addictive personality" (Chiauzzi and Liljegren, 1993). According to its supporters, the addictive personality is a distinct psychological trait that predisposes certain individuals to addiction. People could be getting addictive to things like cigarettes due to a predisposition for such addictive behaviours in their personality. Research has been focused on looking at whether a trait or set of traits can characterise all people addicted to drugs or alcohol. Investigations into addictive personalities assume that there is a general tendency to get addicted. However, these studies fail to produce consistent results.

This questionnaire study allows a replication of the results observed in the previous study. This study looks at differences in responses between smokers and individuals who experience cravings for general food and drink substances. Looking at how a smoker's description of craving differs from that of someone who is not addicted to anything might show that there are differences in their personalities. A difference in response patterns between these two groups might provide information about addictive personalities.

Most of the questionnaires and literature on craving have been restricted to addictive substances, such as drugs and alcohol. The craving questionnaires do not usually focus on everyday craving for food or drink. The EI theory however, is not restricted to cravings for such addictive substances but can be applied to craving for any substances or behaviour. Everyday cravings for food and drink can be as disruptive to people as a craving for cigarettes. The previous study showed that there did not appear to be a difference in responses to cravings for food, drink and addictive substances such as cigarettes and alcohol. This study takes a closer look at whether there are any differences between descriptions of cravings for food and drink and cravings for cigarettes by comparing the cravings smokers have for tobacco and other substances. This would provide us with information about whether tobacco cravings are typical of desire in general or if a craving for an addictive substance like tobacco is different from an everyday craving for food or drink. It also compares the other substance cravings of smokers to cravings experienced by people who do not smoke. This would provide us with more information about both types of cravings and in turn would allow us to tailor the coping mechanism to suit the craving type in question.

The statements used in this questionnaire were adapted from the previous one (see Appendix B), and again included statements about internal and external cues, visual and olfactory imagery and expectancy statements. The auditory imagery statement was excluded from this questionnaire, as the results from the previous study showed that it was not applicable to craving. A new statement "my body needs it" was included to replace the physiological sensations statement (I am hungry/thirsty/physical discomfort), as the wording in the statement did not seem applicable to tobacco and alcohol cravings. The statements were incorporated from the EI theory as well as Tiffany's theory. To shorten the questionnaire and avoid repetition, this questionnaire

did not separate craving descriptions and triggers of craving. The respondents were asked to rate how well a list of fourteen statements, which included both descriptive statements and a few adapted trigger statements, applied to their craving experience. The intrusive thoughts statement was included in the new questionnaire as well as some adapted trigger statements about mood, external cues and habit. The descriptive statements were also from the previous questionnaire and included imagery statements, expectancies and mood.

The trigger and descriptive statements were mixed together and the respondents asked to rate how applicable each statement was to their experience. The previous study showed that respondents did not attribute their craving to a particular trigger, but experienced it as being spontaneous. This questionnaire focused more on the descriptions of craving rather than triggers because people do not appear to be aware of what brought on their craving. It was intended that the respondents would keep the questionnaire with them and fill it out the moment they experienced a craving. This would provide more accurate answers that are not subject to bias. Individuals would respond with answers that represent what they think their craving ought to be.

5.1 Method

The questionnaire was included in the introduction packs sent out by the University of Sheffield to 1500 new students in August 2003. They were also supplied with a postage paid envelope in which to send the questionnaire back.

The questionnaire had two sides; one side was to be completed for a craving for food or drink. The respondents had to rate the strength of their craving and then rate how well a list of statements described their craving. This was repeated on the second side of the

questionnaire, which had to be filled out for tobacco cravings if the respondent smoked. Instructions on how to complete the questionnaire and a definition of craving were given at the top of the questionnaire. The instructions were as follows:

"Please keep this questionnaire nearby until you find that you are craving food, drink, or tobacco. If you use any tobacco product, please fill out both sides before returning to us. If you do not use tobacco, just fill out this side."

The respondents had to fill out the first side of questionnaire for a craving for food or drink. At the bottom of the first side were further instructions about filling out the second section of the questionnaire and were as follows:

"Thank you. If you do not use tobacco in any form, tick this box ☐ and return the form to us in the envelope provided, or to the address at the top of the page. If you do use tobacco, complete the other side too".

It was intended that respondents who did use tobacco should keep the questionnaire with them until they had a craving for tobacco, and then complete the second side before returning the questionnaire. Those who did not use tobacco were asked to return it after completing the first side.

The respondents rated the strength of their craving on a Likert scale of 1 (*very slight*) to 10 (*overwhelming*) and rated the statements on a Likert Scale of 1(*not at all*) to 5(*definitely*) and circled the number depending on how much the statement applied to them.

5.2 Results

Three hundred and sixty seven completed questionnaires were returned by the cut off date of 20th September 2003, giving a response rate of 24%. Nine of the questionnaires were not completely properly and could not be included in the analysis, the respondents had not specified their craved substance, or they had specified a non-substance craving (e.g. sleep). Age ranged from 17 years to 48 years with a mean age of 18 years and 6 months. Responses were received from 237 females and 125 males (five did not specify their sex).

The first side of the questionnaire was to be filled out when they experienced a craving for food or drink. As in the previous questionnaire, the sample was split up into 5 groups of chocolate, snack, soft drink, alcohol and general food cravers. 111 people reported chocolate cravings (30%), 92 people reported snack cravings (25%), 88 people reported general food cravings (24%), 62 people reported cravings for soft drinks (17%) and 14 people reported cravings for alcoholic drinks (4%). In addition to this, 35 people (10%) filled out the second side of the questionnaire for their tobacco cravings. The response rates are similar to those observed in the first questionnaire, except that fewer tobacco responses were received than anticipated. The tobacco users would have had to keep the questionnaire with them for a longer period of time, which increased the chance of not returning the questionnaire. In the previous study, 21% of the sample craved chocolate. Snack cravings were also reported by 21% of the sample. 19% of the sample reported general food cravings, 17% reported tobacco cravings, 16% reported soft drink cravings and alcohol cravings were reported by 6% of the sample.

5.2.1 Analysis of general food and drink cravings

The strength of craving scores from the first side of the questionnaire did not differ significantly between the craved substance groups ($F(4,350) = 1.66$, $MSE = 2.79$, ns) with an overall mean of 5.6 and a standard deviation of 1.7. Every point on the ten-point scale was used; the mode was 6 used by 97 people. This replicates the results of the previous questionnaire study, again suggesting that there is no difference between the craving ratings of the different substance groups.

Of the fourteen craving statements, eight showed a strongly skewed distribution with a modal response of 1 "not at all". The statements used in the questionnaire along with mean response ratings are listed in Table 4. These included the statements about negative mood and an external cue statement; "I was stressed/anxious/sad" was given a rating of "not at all" by 58% of the sample and 64% rated the statement "I saw/heard/smelt it" as being "not at all" descriptive of their craving experiences.

Other statements that received a modal rating of "not at all" were the statements "I am not able to have it right now" (61%); "My body needs it" (50%); "I always have it at this time/place" (53%); "I want it because I am tired/uncomfortable" (49%); and "I am trying to resist having it" (35%).

The statement "I have nothing else to do/I am bored" also had a modal responses of 1, with 26% of the sample rating the statement as being "not at all" descriptive of their cravings. This statement was also given higher ratings by the sample. Fifty-three percent gave it higher ratings between 3 and 5. This replicates the results from the previous study for this statement and provides more support for the idea that few of the potential triggers are actually recognised as such by individuals who are craving.

Five of the descriptive statements received ratings in the range 3 to 5 (*definitely*) by the sample. The intrusive thoughts statement had a modal response of 4, with 72% of the sample giving a rating in the range of 3 - 5. In the previous questionnaire study, this statement also received high ratings, suggesting that the subjects did not know what brought about their cravings but experienced them as being sudden and spontaneous.

Other statements which received high ratings were "Having it would feel very comforting" (80%); "I am imagining the smell/taste of it"(70%); "I would feel more relaxed if I had it" (64%). The statement "It is easily available right now" also received high ratings from 70% of the sample, with a modal response of 5. The statement about visual imagery (I am picturing myself having it) had a more normal distribution, though 58% of the sample gave it a rating in the range 3 and 5.

How well do these statements describe your craving?	Shortened Name	Mean rating	% age respondent's ratings (1 = not at all; 5 = definitely)				
			1	2	3	4	5
Having it would feel very comforting	Comfort	3.5	7	13	24	**30**	26
It is easily available right now	Availability	3.5	16	14	13	20	**37**
I suddenly thought about it	Intrusive Thoughts	3.3	11	16	21	**36**	15
I am imagining the smell/taste of it	Olfactory Imagery	3.2	16	14	21	**27**	22
I would feel more relaxed if I had it	Relaxed	3.0	16	20	23	**26**	15
I having nothing else to do/I am bored	Bored	2.8	**26**	21	16	20	16
I am picturing myself having it	Visual Imagery	2.8	24	20	**25**	19	12
I am trying to resist having it	Resistance	2.5	**35**	22	16	16	11
My body needs it	Needs	2.1	**50**	14	16	11	8
I am not able to have it right now	Unable	2.0	**61**	11	7	8	13
I want it because I am tired/uncomfortable	Physiological Sensations	2.0	**49**	24	12	11	5
I always have it at this time/place	Habit	1.9	**53**	20	13	8	6
I saw / heard / smelt it	External Cue	1.9	**64**	13	7	8	9
I feel stressed / anxious / sad	Negative Mood	1.8	**58**	19	11	9	3

Table 4: Respondents' acceptance of descriptive statements as characterising their general food or drink craving episode along with shortened names, sorted by mean rating. Percentages may not sum up to 100 due to rounding. The mode for each statement is in bold.

Chi-squared tests were carried out on the scales to see if there were any contingencies between the responses to the scales and the craving subgroups. Of seven statements that received high ratings, four statements did not differ according to their craved substance. These were "I suddenly thought about it", "Having it would be very comforting", "I am imagining the smell/taste of it", and "It is easily available right now". (All $\chi 2 < 26.30$, df = 16, ns). None of the equivalent statements in the first questionnaire studied differed between craved substance groups.

The ratings for the statement "I would feel more relaxed if I had it" did differ according to the craved substance ($\chi 2$ (12, N = 366) = 35.27, $p < 0.05$). As in the previous questionnaire, the alcohol cravers differed in their responses to the other substance groups (Figure 12). Around 70% of the group gave this statement a rating of between 4 and 5 compared to 40% to 50% of the other groups. Higher ratings were also seen in the soft drink group with 80% giving it a rating between 3 and 5.

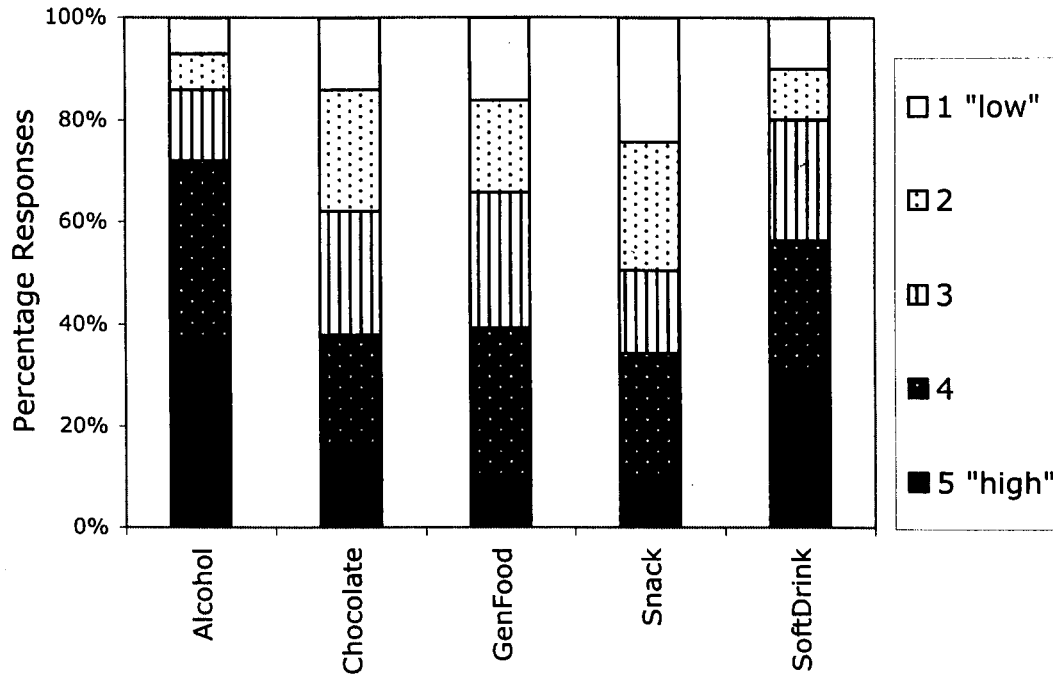

Figure 12: Ratings for relaxed statement as being descriptive of the respondents' craving episodes divided by substance group.

As in the Questionnaire 1, the visual imagery statement also differed across substance groups ($\chi 2$ (12, N = 366) = 32.06, $p < 0.01$). This statement was given high ratings from the alcohol group; 93% of the alcohol group gave this a rating between 3 and 5 on the scale compared to 46% - 58% of the other groups. The alcohol cravers in Questionnaire 1 also gave this statement high ratings with 30% of the alcohol group gave it a top rating of 5.The chocolate group, however, did not rate this statement as being very descriptive of their craving. Fifty-three percent of the chocolate cravers gave the statement low ratings between 1 and 2, compared to 7% to 43% of the other groups (See Figure 13).

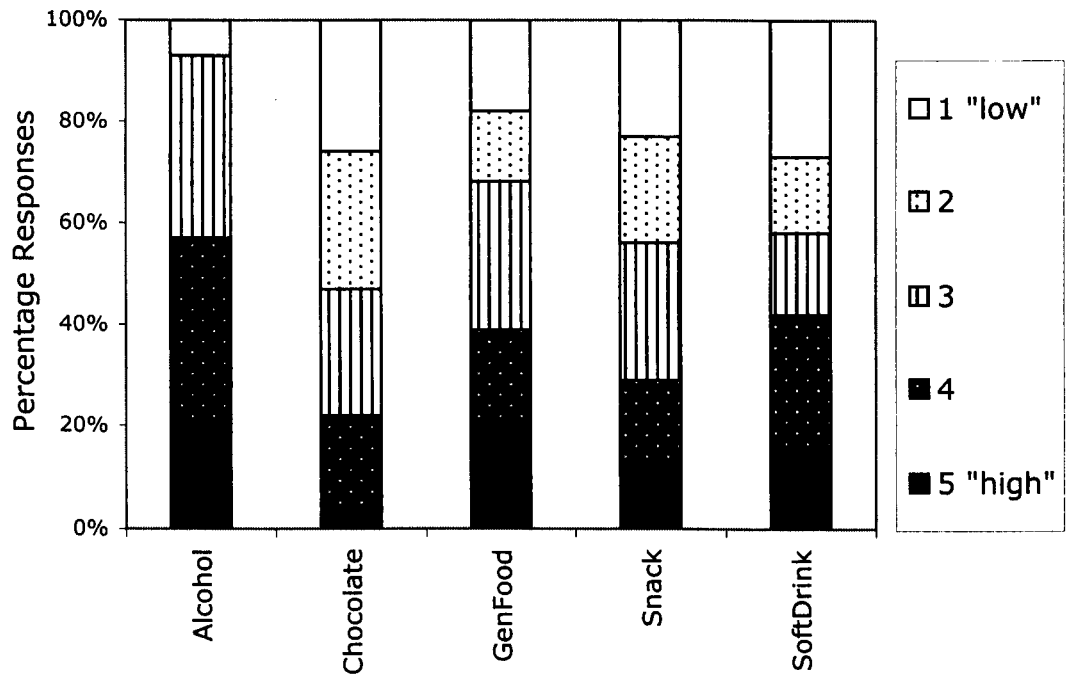

Figure 13: Ratings for visual imagery statement as being descriptive of respondents' craving episodes, divided by substance group.

Chi-Squared tests were chosen because we could not assume a normal distribution of responses to the questionnaire statements (as indeed Table 4 showed). However, to explore the differences between smokers and non-smokers, Independent samples t-tests were carried out on their responses to the questionnaire statements when rating their everyday cravings for food and drink. The only statement that was significantly different was the visual imagery statement (I am picturing myself having it; $t(364) = -2.68$, $p < 0.01$). The smokers gave this statement an overall higher rating than non-smokers (mean for smokers = 3.36; mean for non-smokers = 2.74).

5.2.2 Analysis of tobacco cravings compared to food and drink cravings of smokers

A separate analysis was carried out on the data collected for tobacco craving. The ratings for the descriptive statements of tobacco cravings were compared to the responses those same respondents made on the first side of the questionnaire, in a within-subjects design. The following graph (Figure 14) shows the mean ratings from both the tobacco and other substance cravings of smokers for each descriptive statement.

Repeated measures t-tests were carried out on the craving strength data to see if there was a difference between the two samples. There was no significant difference between the strength of craving scores for tobacco cravings (mean = 5.90) compared to strength of cravings for other general food and drink cravings (mean = 5.80; $t(32) = 0.38$, ns.).

Difference scores were calculated between statement ratings for tobacco cravings and statement ratings for other substance cravings. One-sample t-tests were carried out on the difference scores to see if the responses from the two samples differed. The Null

hypothesis is that both samples should have similar responses to the statements so there should not be a difference between cravings for food or drink and tobacco.

Seven of the fourteen statements on the questionnaire had significant differences between their responses during tobacco cravings and cravings for other substances. These included the statements about resistance (I am trying to resist having it: $t(35) = 3.31$, $p<0.01$), the negative mood statement (I feel stressed / anxious / sad: $t(35) = 2.34$, $p<0.05$), the relaxed statement: $t(35) = 2.43$, $p < 0.05$ and the unable statement (I am not able to have it right now: $t(35) = 2.25$, $p<0.05$). The tobacco group gave these statements higher ratings than the other substance groups.

Significant differences were also seen in the two samples for the two imagery statements (Visual imagery: $t(35) = -2.55$, $p<0.05$; Olfactory imagery: $t(35) = -3.15$, $p<0.01$) and the availability statement (It is easily available right now: $t(35) = -2.33$, $p<0.05$). These statements received higher ratings from the other substance group. Of course with fourteen t-tests, the change of not making a Type I error is 0.95^{14} i.e. 0.49. So one or two of these maybe spurious, but it is highly improbable that all seven are spurious.

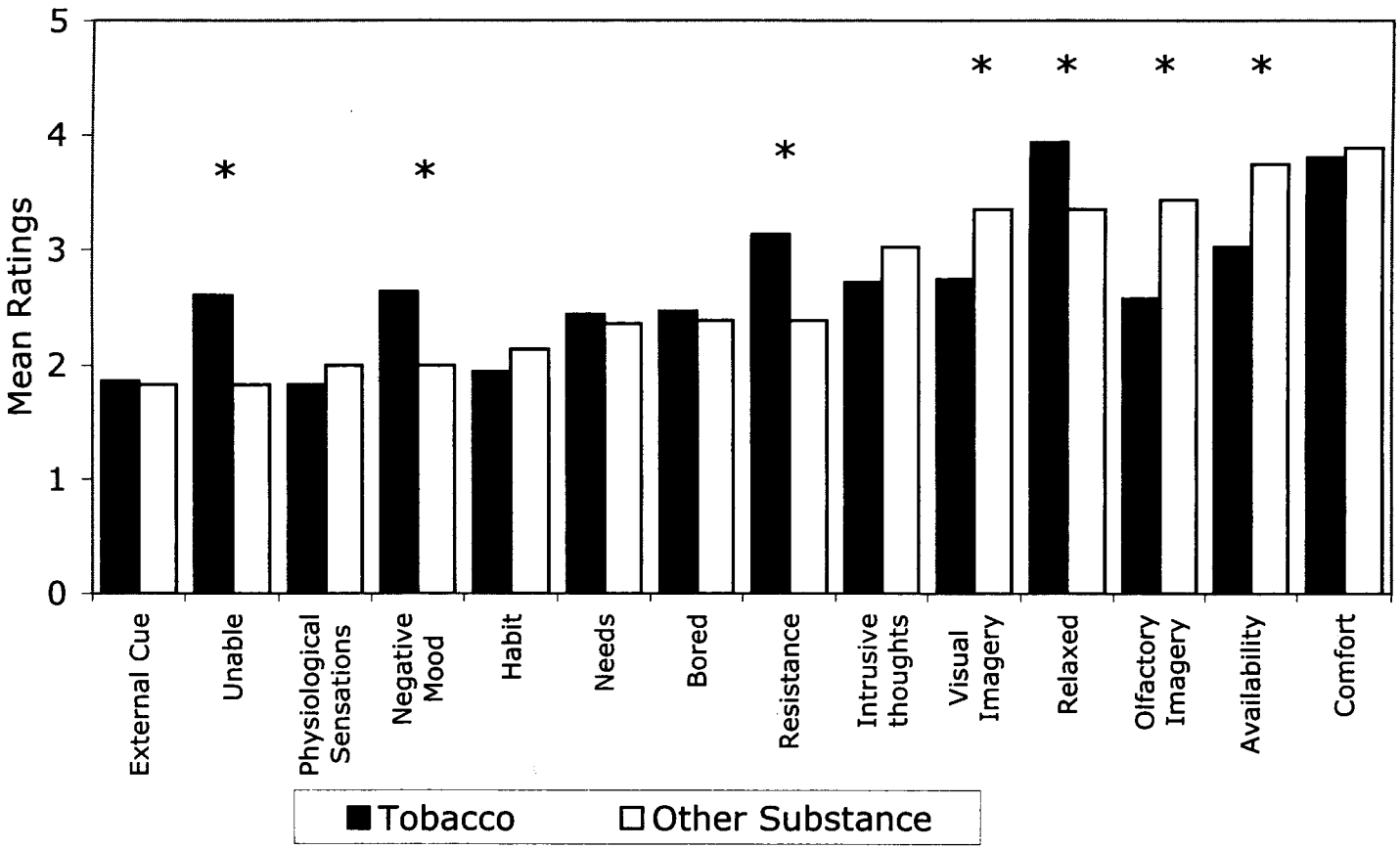

Figure 14: Mean ratings for descriptive statements for tobacco and other substance cravings of smokers, in order of increasing mean response ratings of overall sample. An asterisk represents statements that are significantly different.

5.3 Preliminary Discussion

The analysis of the smokers' cravings for tobacco and other substances showed significant differences between the responses for seven of the descriptive statements. The previous questionnaire study did not show these differences between tobacco and other substance cravings. In the previous study, neither the statement "Having it would feel very comforting right now", nor the olfactory and visual imagery statements showed the differences seen in this study. The comfort statement and the olfactory imagery statement also did not have any significant differences across the craved substance groups in the first questionnaire study. The response patterns for the visual imagery statement were not replicated either as the statement was rated higher by the tobacco group in the previous questionnaire study. The effects seen in the previous questionnaire were not replicated in this study.

The pattern of responses observed in this study support Tiffany's theory more than the EI theory. Statements about blocking "I am unable to have it right now" and "I am trying to resist having it" were significantly different between tobacco and other substance cravers. Tiffany's theory suggests that a craving occurs when the automatic substance use behaviour is blocked either by internal or external factors. The results from this sample appear to be more consistent with Tiffany's account of craving than the EI theory. This is again different to the pattern of response observed in the previous study, as that sample was more consistent with the EI theory than Tiffany's model.

However, on closer inspection, these differences between smokers' ratings of tobacco and other cravings could be biased by stereotypical answers, due to the instructions not being very clear. Looking at the time of craving for both the tobacco and food/drink cravings showed that many respondents were filling both sides of the questionnaire out

at around the same time. The time interval between the two cravings was sometimes less than 5 minutes apart. This suggests that the respondents were filling out one side of the questionnaire and then completing the other side immediately, rather than waiting until they actually experienced a craving for tobacco. This would mean that the responses are biased with retrospective recall giving stereotypical answers rather than "at-the-time" answers.

The time interval between the completion of the two sides of the questionnaire was separated into seven groups of time interval: < 5 minutes, between 5 -10 minutes, between 10 – 15 minutes, between 15 -20 minutes, between 20 -25 minutes, 25 - 30 minutes, and more than thirty minutes. A large portion of the tobacco side of the questionnaire had been filled out less than five minutes (20 questionnaires) apart with the rest being filled out mainly after a time interval of more than thirty minutes (15 questionnaires). To account for differences between stereotypical answers and more accurate "at-the-time" responses, the tobacco cravers were separated into two groups based on a time interval of more than thirty minutes between the completion of both sides of the questionnaire. This was to ensure that the respondents were describing their craving for tobacco and not just having a cigarette with their coffee or after a meal.

5.4 Further Results

5.4.1 Further analysis of tobacco cravings compared to food and drink cravings

The repeated measures t-tests carried out on the data were repeated, this time comparing the responses for food and drink cravings with tobacco cravings but excluding the group who had filled out both sides of the questionnaire consecutively. Mean ratings for all the statements can be seen in Figure 15. When looking at the statements that received high ratings overall; the responses to the resistance statement "I am trying to resist

having it" were significantly different between the two substances ($t(13) = 2.74$, $p < 0.05$). The respondents rated this statement higher when they were craving tobacco than when they having a craving for food or drink (mean rating tobacco = 3.14; mean rating other substances = 2.21). This suggests that smokers are more likely to try to resist giving in to their tobacco craving than other cravings. Significant differences were also seen in the olfactory imagery statement ($t(13) = -1.07$, $p < 0.05$). This statement received higher ratings for the other substance cravings of smokers. This was also seen in the results from the previous study. Overall, however, there is no difference between cravings for addictive substances like tobacco and everyday cravings for food and drink in people who are addicted to a certain substance like cigarettes.

Chi-Squared tests were also carried out on the data to compare the distribution pattern for smokers and non-smokers. To account for the smaller sample size of the smokers, the rating scales were collapsed and responses of 3 to 5 were coded as "high" and responses between 1 and 2 were coded as being low. These tests did not show any significant differences between smokers and non-smokers in their cravings for food and drink (all $\chi 2 < 2.5$, $df = 1$, ns).

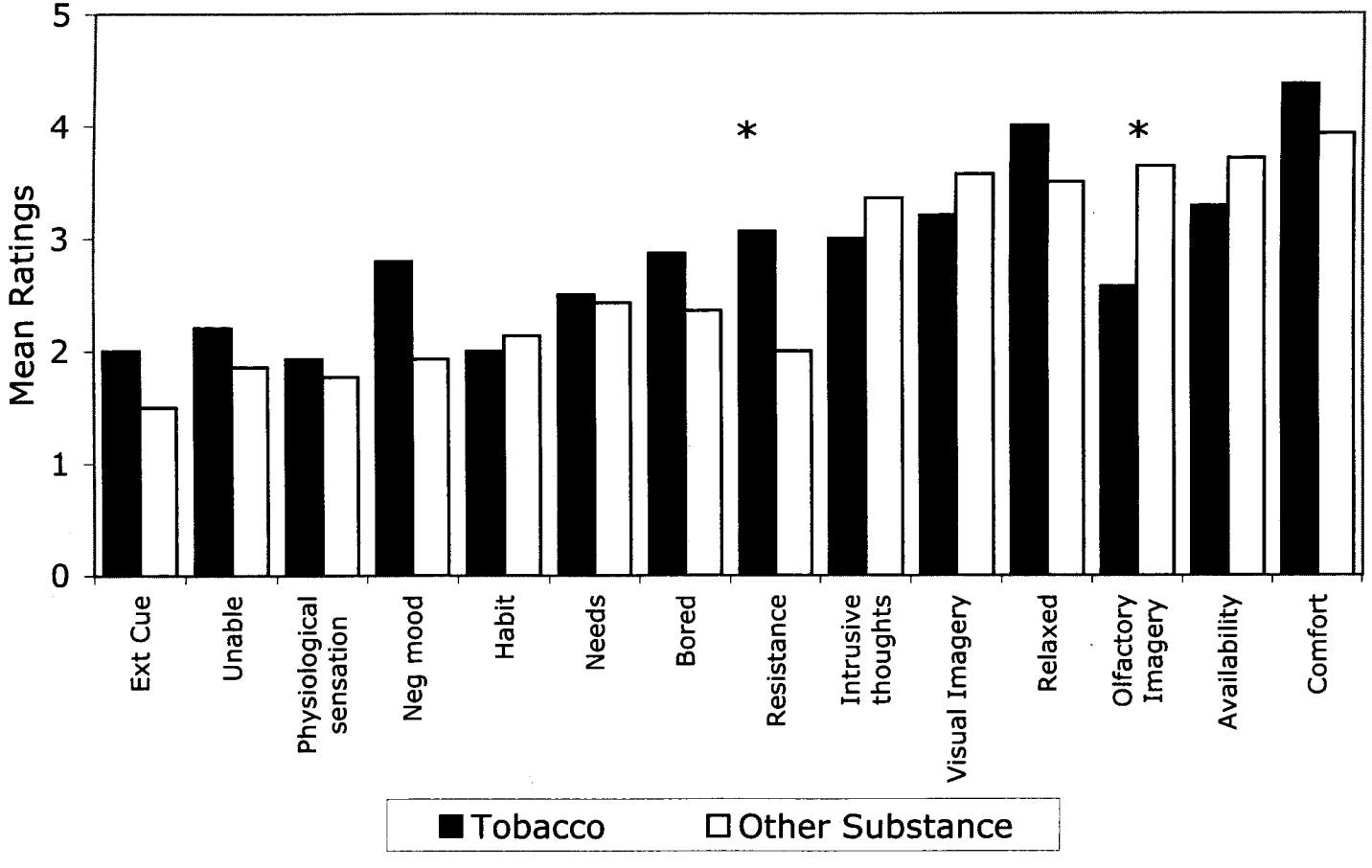

Figure 15: Mean ratings for descriptive statements for tobacco and other substance cravings of smokers, excluding those with a time interval of < 30 mins. An asterisk represents statements that are significantly different across groups. In order of increasing mean rating responses in sample.

5.4.2 Analysis of tobacco cravings comparing time of response

The tobacco craving responses that had been made immediately after the completion of the first side of the questionnaire (immediate smokers) were also compared to the rest of the tobacco cravings (later smokers). This would be comparing retrospective responses to craving with "at the time" responses.

The craving strength analysis did not show any differences between the two groups ($t(32) = 0.57$, ns).

Most of the statements received higher ratings when the questionnaire was being filled out at the time of craving rather than retrospectively. The mean response ratings for all the statements can be seen in Figure 16. However, these differences were not significant. The differences between the ratings were statistically significant for two of the statements: Negative mood (I feel stressed / anxious / sad: $t(33) = 2.22$, $p < 0.05$) and comfort (Having it would be very comforting right now: $t(33) = 2.21$, $p < 0.05$). A statement approaching significance were the intrusive thoughts statement (I suddenly thought about it), which received higher ratings when the questionnaire was filled out at the time of craving. The tobacco cravers who filled the questionnaires out at the time of craving rated these statements higher than the group that was completing the questionnaires based on retrospective recall.

Chi-Squared tests were also carried out to look at any differences between smokers who had filled both sides out consecutively (stereotypical smokers) and those who had waited until later (later smokers) in their responses to the descriptive statements. To account for the smaller sample sizes, the responses between 1 and 2 were again coded as "low" and responses between 3 and 5 were coded as being "high". In contrast to t-tests, the results from the chi-squared tests did not prove to be significant (all $\chi 2 < 3.5$,

df = 1, ns). One of the statements that approach significance was the negative mood statement (I am stressed / anxious/ sad). This statement received higher ratings when the questionnaire was being filled out at the time of craving. The lack of significance in these tests could be due to the collapsing of the ratings scales as the contingencies could lie within the "high" and "low" groups.

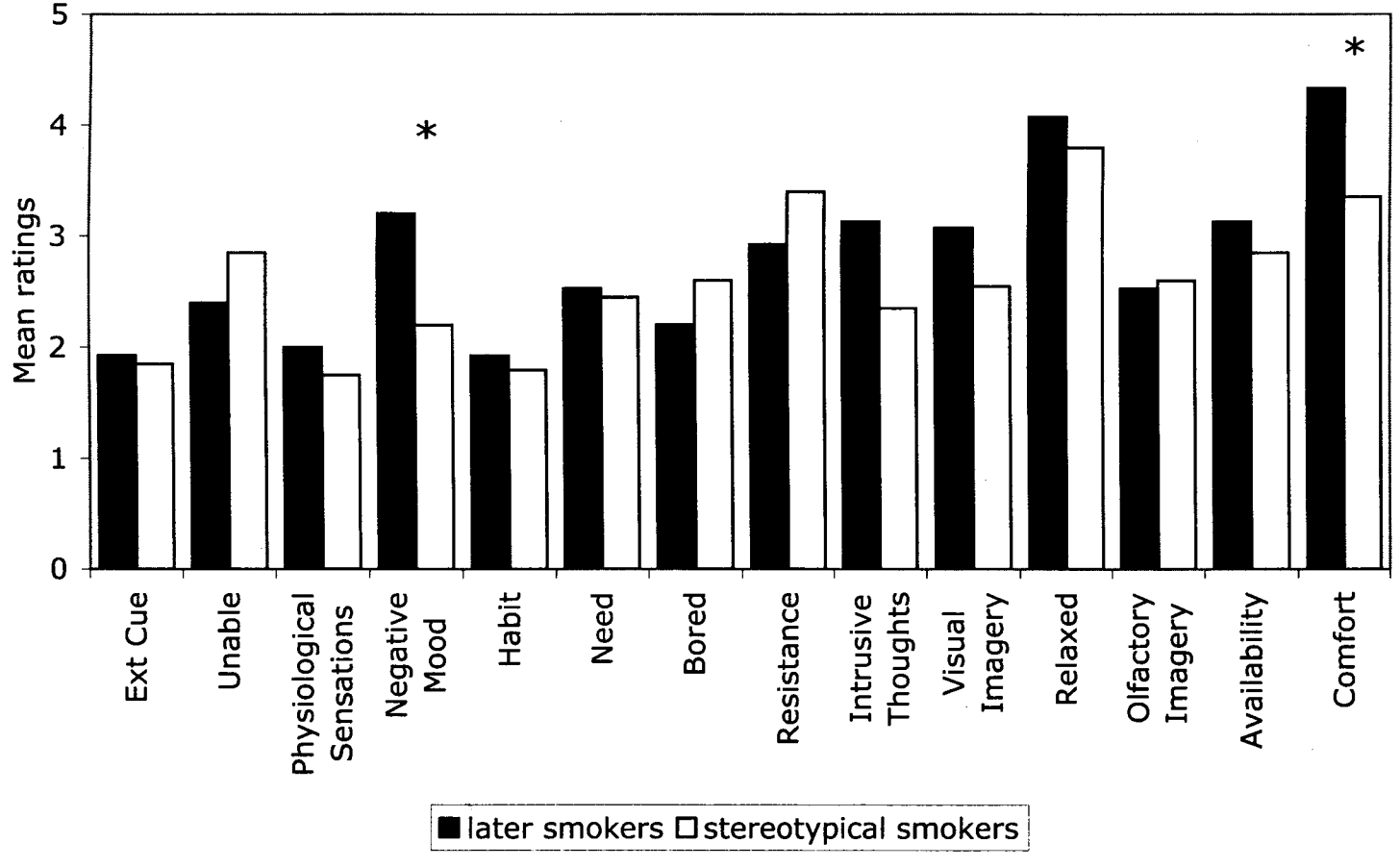

Figure 16: Comparing mean responses for the descriptive statements for stereotypical and later tobacco cravings. Statements in order of increasing mean response rating of overall sample. The asterisks represent statements where the two groups significantly differ from each other.

5.5 General Discussion

The data obtained on the strength of craving ratings did not show any differences between substance groups. The between subjects analysis which compared the cravings for general food, snack and drinks of smokers and non-smokers did not show any significant differences. There was also no significant difference in the strength of craving ratings that smokers had for tobacco cravings when compared to their cravings for other substances. This replicates the findings from the previous study, and suggests that everyday craving for substances that are not addictive are similar in intensity to the cravings experienced for addictive substances like cigarettes.

The analysis carried out on the descriptive statements for everyday craving for food and drink again showed that subjects do not seem to be aware of what causes their craving and that they experience them as being spontaneous. The statement "I suddenly thought about it" received high ratings from all the substance groups in the sample. Lower ratings were given to statements about mood, external cues and habit. This replicates the findings of the previous questionnaire study. The respondents did not attribute their craving to any of these factors since the triggers are acting below conscious awareness. The individual is unaware of the trigger but experiences the craving as being spontaneous and intrusive.

Many of the smokers who completed both sides of the questionnaire had filled both sides at around the same time. Twenty respondents filled both sides of the questionnaires minutes apart. This suggests that some of the respondents waited until they experienced a craving for food and drink and filled out the first side, and then filled out the second side immediately after. There is no way of knowing if the respondents misunderstood the instructions on the questionnaire, which required them to fill the first

side of the questionnaire when they were experiencing a craving for food or drink, and the second side when they were experiencing a craving for tobacco. There is also no way of determining which responses were made at the actual time of craving. For analysis, a time interval of 30 minutes was used to differentiate between questionnaires that were completed at the time of each craving and questionnaires that were completed consecutively. The problem with the time of completion is a fault in the design of the questionnaire as the instructions on the questionnaire should have been clearer. The bottom of the first sides tells the respondents to tick a box if they do not use tobacco in any form and then return the form, or, if they do use tobacco, then they are asked to complete the other side. This could have been misleading to the respondents and they might have filled out the other side even when they were not craving tobacco. This would mean that the responses obtained for tobacco cravings are not all "at-the-time" of craving and could be biased by retrospective, stereotypical responses. The instructions should have been carefully stated and not ambiguous and it should have been clear that both sides of the questionnaire should be completed when the respondents experienced a craving for the substance.

A different response pattern is observed on the separation of the tobacco cravers into the two groups. There are no significant differences obtained for responses between tobacco and other substance cravings. The statements that did differ was the "I am trying to resist having it" and the "I can smell/taste it". Smokers rated the resistance statement higher when craving tobacco than when experiencing a general substance craving. This replicates the findings of the previous study where tobacco cravers were more likely to resist giving in to their cravings. The olfactory imagery statement received higher ratings for other substance cravings. This was also seen in the previous study, where tobacco cravers did not rate this statement as being very descriptive of their craving.

The other statements did not differ significantly from each other. This suggests that tobacco and other substance cravings of smokers are similar. Although, of course with so few smokers the test lacks statistical power and so any true differences would be difficult to detect. The results observed do not provide any evidence for the existence of an addictive personality type. There does not appear to be any differences between cravings for an addictive substance and general cravings. Furthermore, the results did not show any differences between the descriptions of general food and drink craving between smokers and non-smokers.

When comparing the responses between smokers filling the questionnaires out at the time of craving and retrospectively, there were significant differences in the negative mood statements and the comfort statement. The smokers who were filling the questionnaires out at the time they had a craving gave these statements higher ratings than those who filled out the questionnaire based on retrospective recall. This is in accordance with the EI theory in that once they are craving, they have positive expectancies about the effect the substance would have on their affective statement. It would be comforting for them to have their desired substance and relieve their negative mood. For most of the statements, the ratings for the two groups were similar. Though not statistically significant, larger differences were also seen in the intrusive thoughts statement and the visual imagery statement. Higher ratings were seen in the smokers who waited until they were craving. This suggests, that at the time of craving, respondents have little insight into what causes their craving. Once this craving is in awareness, visual imagery maintains the craving episode. When filling the questionnaires out retrospectively, the respondents are more likely to attribute a trigger to their craving based on factors they think could bring about a craving episode. These findings replicate the results from the previous study and also are in accordance with the

EI theory. Another statement which approaches significance is the statement "I am unable to have it right now", this statement incorporates the blocking mechanism that Tiffany proposes. However, this statement receives higher ratings from smokers who fill both sides of the questionnaire consecutively. The resistance statement also receives higher ratings from this group. It appears that more support is obtained for the Tiffany model of craving when the questionnaire is filled out retrospectively.

The differences between the immediate and later smokers suggest that responses made by retrospective recall are often subject to bias. The differences between the two groups in this study suggest that the time the questionnaire is being filled out is important in order to gain an accurate account of the craving episode. If the questionnaire was being completed by retrospective recall of past experience then the responses made would be influenced by their schematic ideas about what a tobacco craving "ought" to be like. This would not be an accurate description of their experience and would lead to either an overestimation or underestimation of their past craving experiences. Many of the questionnaires reported in the craving literature ask respondents to fill them out retrospectively. The results from this study would suggest that this is not a reliable measure of an individual's experience. This would mean that a lot of research that has already been carried out using traditional methods of self-report would be misleading as recall errors and bias can create false associations between variables. Research carried out by Stone and Shiffman (1994) also raises doubts about the accuracy of retrospective methods and Shiffman and colleagues (1996; 1997) often use palm-held computers in their research. Their research has shown that participants tend to overestimate their negative affect or the number of cigarettes they smoked during a lapse (Shiffman et al., 1997). They suggest that using retrospective questionnaires might mean that researchers are not really measuring what they believe they are measuring. Stone and Shiffman

(1994) have shown that participants are unable to accurately recall details after a period of a few months. Some questionnaires ask participants about the relapse incidents over a period of three years (LCRR- Veltrup, 1994). A study by McKay, O'Farrell, Maisto, and Connors (1989) showed that attribution for lapses are changed over time. Furthermore, the recall of affective states is influenced by how the participant is feeling when filling out the questionnaire as well (Hodgins, el-Guebaly, and Armstrong, 1995).

Studies that explore the craving phenomenon often involve participants providing an account of what their past craving episodes feel like or how intense their cravings are. To obtain an accurate representation of their craving, participants should be asked to describe what they feel at the time of craving, as well as obtaining the assessments in the participants' environments as they went about their everyday activities. Salkovskis & Reynolds (1994) used a smoking-related intrusive thoughts questionnaire where participants were asked to evaluate the frequency and intensity of 12 thoughts, which had been identified as commonly occurring craving-related thoughts. The participants were asked to rate how often the thought occurs when they are tempted to smoke on a scale of 1-5. The list included thoughts about giving up smoking and images of smoking-related triggers. However, this questionnaire was not completed at the time of craving. Instead, the participants used retrospective recall to complete the questionnaire, which might not have been an accurate representation of how they were feeling or what they were thinking of at the time of craving. The questionnaire studies discussed in this thesis differs from these studies because the questionnaires were meant to be completed at the time of craving and in the participants' natural environment. This would probably provide a more precise account of the triggers and craving-related thoughts.

Doubts about the validity of these self-report measures would not only mean that changes in the way these experiences are measured are necessary but also that past research needs to be reinterpreted. Diagnosis and treatment relies heavily on the retrospective reports made by patients and if reports were inaccurate then the treatment measures that are taken would not be very effective. The results observed in this study would suggest that the use of retrospective recall produces a different pattern of responses than when questionnaires are completed when the respondent experiencing a craving. To gain a more accurate account of the craving experience questionnaires should be completed at the time of craving.

6 Experiment 1 – Effect of imagery tasks on cigarette craving

Cravings are typically reported to be frustrating and disruptive. Studies have shown that craving impedes performance of concurrent cognitive tasks and that craving represents the operation of cognitively demanding processes (Hillebrand, 2000; Cepido-Benito and Tiffany, 1996 and Sayette et al., 1994). The results from a study by Gross, Jarvik and Rosenblatt (1993) showed that craving tends to bias attention toward target-related stimuli. Depriving smokers overnight resulted in impeded colour naming of smoking related words in a modified version of the Stroop task. Food deprivation has also been shown to have similar effects on food words (Channon and Hayward, 1990; Lavy and van-den-Hout, 1993). Craving has also been shown to interfere with concurrent cognitive tasks that have substantial working memory requirements. A study by Zwann and Truitt (1998) showed that inducing craving in smokers impaired the accuracy of reading comprehension, particularly on the more complex sentences. Participants with low reading span also showed a decrease in accuracy. Results from these studies suggest that craving interferes with concurrent tasks by occupying the limited-capacity systems of working memory as well as directing attention toward craving related information. If craving causes an interference with concurrent cognitive tasks, then it is quite possible that a concurrent task could be used to interfere with an individual's craving experience.

Studies on thought suppression have been shown to be ineffective. A study by Palfai, Monti, Colby and Rohsenow (1997) on thought suppression in alcoholics showed that heavy social drinkers who attempted to suppress their urges to drink experienced an increase in accessibility to alcohol related information. They suggest that urge suppression may prime information in memory in relation to drinking behaviour and

lead to increased drinking. Suppression of craving related thoughts are also thought to play a role in restraint-binge cycles in restrained drinkers (Palfai et al., 1997). The deliberate suppression of intrusive thoughts (by actively trying not to think about a target) increases the likelihood of intrusion (Salkovskis, 1989; Salkovskis and Campbell, 1994; Wegner, 1989). When looking at thought suppression in relation to smoking cessation, Salkovskis and Reynolds (1994) found that smoking related thoughts occurred quite frequently and intensely in people trying to give up or cut down on their smoking. They explored the effects of thought suppression in smokers asked to monitor their smoking thoughts, to suppress their smoking thoughts, or to combine the active suppression of thoughts with relaxing breathing exercises. They found that asking subjects to actively suppress their smoking related thoughts resulted in an increased frequency of thoughts compared to the controls. The relaxing exercise also resulted in a lower frequency of smoking-related thoughts. The results from this study suggest that deliberate attempts to suppress smoking thoughts lead to an increase in the occurrence of them. Thus, advising a smoker not to think about smoking would not help him cut down. However, distraction or carrying out another task appears to be more successful in reducing thoughts about smoking. The use of a concurrent cognitive task to interfere with the processes that underlie craving may provide a more effective strategy. To be maximally effective, the task would have to load onto the same cognitive processes that are involved in craving.

Though imagery procedures have been used to induce craving in the laboratory (Tiffany and Hakenewerth, 1991; Weinstein et al., 1997; Weinstein et al., 1998), the precise role of imagery in the craving episode is not something that has been previously explored or explained. As discussed earlier, the EI theory suggests that visual images play an important role in the emotional and motivational aspects of craving. This theory

proposes that craving involves thoughts and images about the substance or activity in question, as well as an awareness of emotional and physiological states, such as withdrawal and unhappiness. The elaboration process suggested by the theory involves the generation and maintenance of target related imagery in the search, retention and manipulation of craving related information. Target related information from the environment is combined in working memory with sensory information held in long-term memory to form quasi-sensory images of the target or target related situations. The images work to maintain the craving episode in conscious awareness, and are first experienced as being rewarding, a substitute for the target substance itself, but eventually become distressing as there is an increased awareness of the difference between the actual and desired state.

The EI model also suggests that the elaboration processes use specific working memory components. Working memory comprises a central executive which acts as the attentional control system, and two limited capacity modality specific slave systems: the phonological loop and the visuo-spatial sketchpad (Baddeley, 1986; Baddeley and Hitch, 1994). The phonological loop is used for the manipulation and storage of auditory and speech based information while the visuo-spatial sketchpad is involved with visual and spatial information. The limited capacity of these subsystems means that they are subject to cognitive interference. A series of experiments by Baddeley and Andrade (2000), investigating the role of working memory in the vividness of visual and auditory imagery, showed that vividness of visual imagery was disrupted by tasks which loaded specifically onto the visuo-spatial sketchpad of working memory. Auditory imagery vividness was disrupted by tasks that loaded onto the phonological loop.

Since visual imagery is known to occupy the visuo-spatial sketchpad of working memory, and if craving involves visual imagery, then it should follow that the same subsystem would be involved in the craving experience. Therefore a concurrent imagery task that uses the same working memory component as craving related imagery would be expected to interfere with the maintenance of a craving episode. The study by Salkovskis and Reynolds (1994) also suggests that visual imagery may be important in cravings experienced by smokers. Smokers were asked to rate the frequency and intensity of their smoking related thoughts and images. Among the most intense and frequent was "Image of yourself under stress, having a cigarette to help calm down or cope", and "Image of yourself in a relaxed place, enjoying a cigarette". The statements used in the study do not involve any other types of imagery, and it might be quite possible that different appetitive targets would be associated with different sensory modalities. For example, taste imagery has been consistently associated with alcohol craving (Westerberg, 2000). However, the results from the questionnaire studies discussed in chapters 4 and 5 also show that the participants regard visual imagery as being descriptive of their craving episodes: the statement "I am visualising it" was rated highly by the sample of cravers. The statement of auditory imagery was not rated by any of the different craved substance group as being descriptive of their cravings.

The present study compares the impact of visual and auditory imagery on cigarette craving in continuing smokers and smokers who had been deprived of cigarettes overnight. Participants gave baseline ratings of cigarette craving and mood, followed by further ratings after each of three blocks of six imagery tasks. The craving intensity in the deprived smokers would initially be high in relation to that of non-deprived smokers. Craving intensity can also be expected to fall following induction of visual

imagery unrelated to smoking, but it should be unaffected by concurrent auditory imagery.

6.1 Method

6.1.1 Participants

The sample consisted of 40 participants, 18 male and 22 female, and comprised students and staff at the University of Sheffield, recruited through an email distribution list and through Psychology Department notice-boards. The mean age of the participants was 24:6 years and they had started smoking at 16:5 years. Participants smoked a minimum of 10 cigarettes a day. They smoked an average of 15 cigarettes a day and had been smoking regularly for about 7 years and 5 months. Fifty percent had previously tried to quit, and 50% were presently trying to cut down on their smoking. All participants received an honorarium of £2 for taking part.

6.1.2 Measurement and materials

Levels of craving were measured using Factor 1 from the Questionnaire on Smoking Urges (see Appendix C - QSU; Tiffany and Drobes, 1991). This consisted of 15 items that loaded on a factor assessing desire to smoke. Participants rated items on a scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

For the imagery tasks, subjects created auditory or visual mental images from written cues, e.g., 'a telephone ringing', 'a game of tennis', respectively. They rated the vividness of each image on a scale of 1 (*no image at all*) to 9 (*image as clear as normal vision/hearing*).

To check that the two imagery tasks did not differentially alter mood, and thereby affect craving, mood was also measured using a 14-item scale (see Appendix D -Diener and Emmons, 1984), containing seven positive and seven negative mood adjectives.

Participants rated how strongly each adjective applied to them at the moment of testing on a scale ranging from 1 (*not at all*) to 7 (*very much*).

Participants were also given a smoking history questionnaire (see Appendix E). This included questions about when they had started smoking, how long had they been a regular smoker and the approximate time they had their last cigarette.

6.1.3 Procedure

Participants were randomly assigned to each of the four experimental groups, such that ten were in each group. Those in the deprived conditions were asked not to smoke any cigarettes, or to use tobacco products or nicotine replacement products from midnight of the day before they were tested. Participants in the non-deprived conditions were not given any specific instruction about smoking; they continued to smoke as normal. Half of each group were subsequently assigned to the visual imagery conditions; the other half was assigned to the auditory imagery conditions. All the participants were tested between 1400 and 1800 hours to minimise diurnal variations in cravings (West and Schneider, 1987).

On entering the laboratory, participants first completed a questionnaire describing their smoking history. They then completed the urge induction procedures, where they read passages constructed by Tiffany and Hakenewerth (1991). They were asked to read to themselves while imagining the described scenario as clearly as possible. The deprived groups were given a passage that was designed to induce cigarette craving, which contained an explicit description of a craving situation for smokers. The non-deprived groups were given a passage about washing dishes, without such craving content. The scripts were equal in vividness and had equal numbers of positive and negative affect descriptions (Tiffany and Hakenewerth, 1991). Both scripts included multi-sensory

elements, but were not specifically visual or auditory. Abstinence and urge induction scripts have an additive impact on craving in cigarette smokers (Drobes and Tiffany, 1997).

Imagery Scripts

Urge Script

You're at a friend's house sitting in a big comfortable chair. You're with people that you've known for a long time. And you've always enjoyed evenings like this in the past. You're sipping a drink and feeling warm, relaxed and totally at ease. Many of your friends are smoking cigarettes around you, you begin to wonder what a cigarette would taste like. The more you think about smoking, the stronger your desire becomes. Maybe just tonight, when you are with your friends having a good time, it would be okay to smoke. Anybody here would be willing to give you a cigarette. How could you really enjoy yourself fully unless you were smoking? Your desire to smoke becomes more intense, and you know that there is no good reason not to smoke tonight.

Neutral Script

Some friends just called to say that they would like to stop over and see you tonight. You decide that you will have to pick up your place and do some cleaning before they come. You start running water into the sink to do the dishes left on the counter. You put a little dish soap into the sink and watch as the foam begins to form and steam rises from the hot water. You plunge your hands into the sink and feel the warm sudsy water between your fingers. When you take your hand out of the water to get a dish from the counter, some water trickles down your arm and drips off your elbow onto the floor. As you stand there doing the dishes, you begin to feel more relaxed because you realise that you'll have plenty of time to get things done.

Participants then completed the QSU Factor 1 scale and the Mood Scale to give the baseline ratings of craving and mood. This was followed by the imagery task, which comprised 18 written cues (see Table 5), based on materials developed by Baddeley and Andrade (2000). The cues were presented in a fixed order, one at a time, in three sets of six. Each cue was printed in 24 point Arial font, on strips of paper measuring 16.5cm wide by 7cm high.

Visual Imagery "Imagine the appearance of....."	Auditory Imagery "Imagine the sound of....."
Firth Court	A telephone ringing
Statue of Liberty	A hair dryer
A rose garden	A cat meowing
A double decker bus	A door squeaking
The Queen	A toilet flushing
Trafalgar Square	Engaged signal of the Phone
A lion in a zoo	Someone coughing
A cemetery	Tap dancing
The Arts Tower	A clock ticking
Big Ben	Snoring
A birthday cake	A dog barking
A rainbow	Wood being sawn
A hot air balloon	A police siren
A launderette	A baby crying
Cows grazing	Horses galloping
A sunset	Church bells ringing
An eagle	A kettle whistling
A baby asleep	A fire alarm

Table 5: Stimuli used in imagery task

On each imagery trial, the experimenter read the cue aloud. The participants were also asked to read the cue to themselves and to close their eyes and to imagine the scene or sound for ten seconds. On hearing a beep from a timer, they opened their eyes and rated the vividness of the image. Following each set of six cues, the participants completed the QSU and the Mood questionnaire. On completion of the final set of questionnaires, the participants were debriefed and given their £2 payment.

6.2 Results

Four ratings of craving strength and mood were collected from each participant, one at baseline and one following each of three blocks of imagery trials. Vividness ratings were recorded for every cued image. For analysis, a mean vividness rating was computed for each block of six imagery trials: hence there were three vividness ratings for each participant. ANOVAs were conducted on the measures of craving, vividness of imagery and mood scores, with *Deprivation* group (deprived v non-deprived) and *Imagery* group (visual v auditory) as between subject variables, and *Time* as a within subject variable (baseline, blocks 1, 2 and 3 for craving and mood; blocks 1, 2 and 3 for vividness).

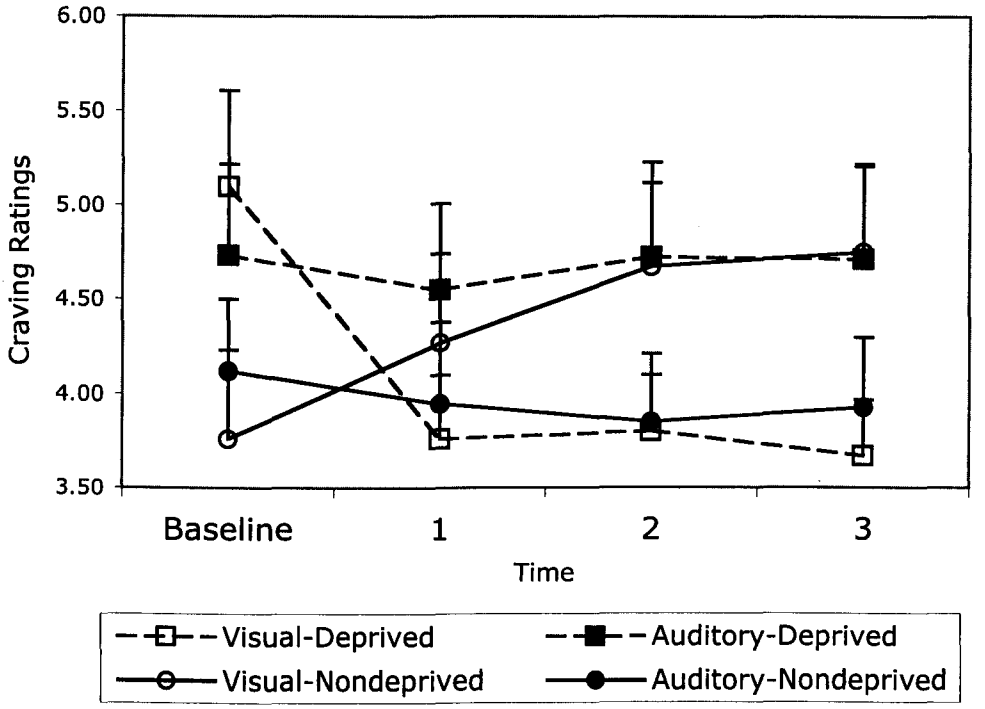

Figure 17: Ratings of craving strength during experiment 1 with error bars indicating +1 standard error

Figure 17 shows variation in craving with time for the four groups. The craving scores showed a significant three-way interaction between *Deprivation* group, *Imagery* group and *Time* ($F(3,108)=7.13$, $MSE=0.52$, $p<0.001$).

An ANOVA was also carried out on the baseline craving strength ratings. At Baseline, both deprived groups reported higher levels of craving than the non-deprived groups (effect of *deprivation* group at Baseline: $F(1,36)=4.42$, $MSE=2.16$, $p<0.05$), but the imagery groups did not differ in their craving levels of craving (effect of *imagery* group at Baseline: $F(1,36)=0.001$, $MSE=2.16$, ns). Though the visually deprived group reported higher levels of craving at Baseline than the auditory deprived group, this

difference was not statistically significant. There was also no interaction between *Deprivation* group and *Imagery* group ($F(1,36) = 0.61$, $MSE = 2.16$, ns).

The three-way interaction was investigated by examining the effect of *Time* within the four experimental groups. Craving scores of the two auditory imagery groups remained level throughout the experiment (auditory deprived $F(3,27)=0.19$, $MSE=0.66$, ns; auditory non-deprived: $F(3,27)=0.30$, $MSE=0.67$, ns). The mean of the visual deprived group dropped from 5.10 at Baseline to 3.76 following the first six imagery cues, and then remained low throughout the experiment ($F(3,27)=9.60$, $MSE=0.51$, $p<0.001$). The mean of the visual non-deprived group rose from 3.76 at Baseline to 4.75 after trial 18 ($F(3,27)=3.91$, $MSE=0.53$, $p<0.05$).

Mood ratings did not show any effects of *deprivation* group or *imagery* modality (Main effect of deprivation: $F(1,36) = 0.04$, ns; Main effect of imagery: $F(1,36) = 0.66$, ns). The three-way interaction was also insignificant ($F(3,108) = 0.98$, $MSE = 0.29$, ns). The variation of mood across the experimental blocks can be seen in Figure 18. A significant effect of *Time* was observed, ($F(3,108)=4.32$, $MSE=0.29$, $p<0.01$). Overall ,mood ratings increased throughout the experiment from a mean of 4.65 at Baseline to 5.05 following trial 18.

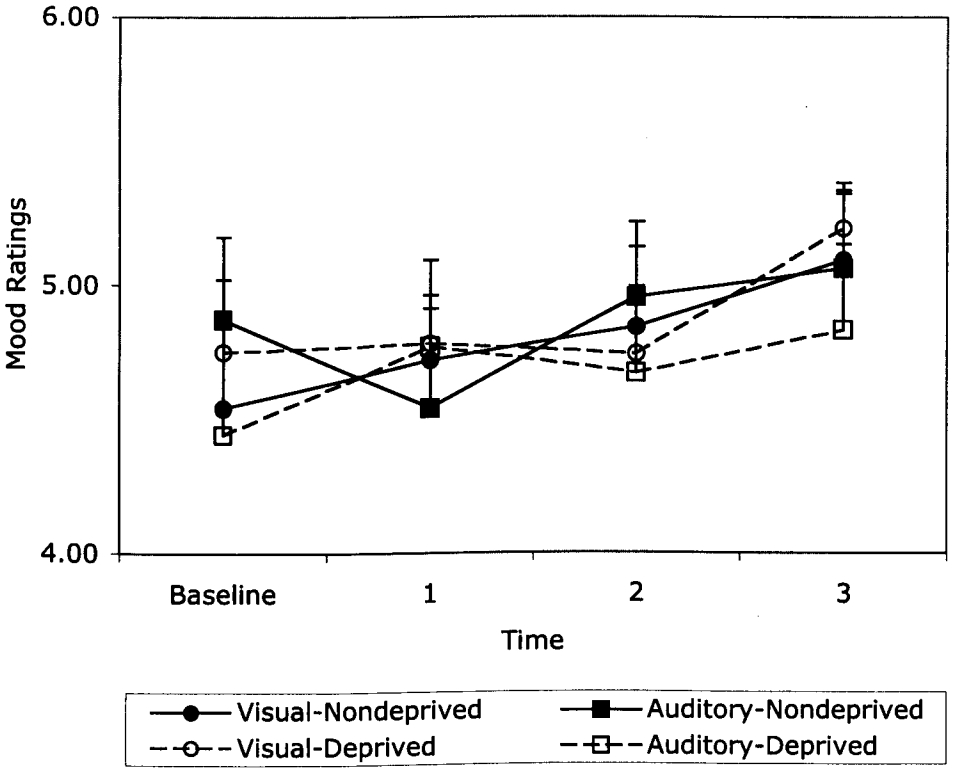

Figure 18: Ratings of mood during experiment 1 with errors bars indicating +1 standard error.

Vividness of imagery did not show any effects of *deprivation* or *imagery* (Main effect of deprivation: $F(1,36) = 0.25$, ns; Main effect of imagery: $F(1,36) = 0.03$, ns). The overall three-way interaction was also insignificant ($F(2,72)= 1.10$, ns). The changes in imagery vividness can been seen in Figure 19. A main effect of *Time* was observed in the analysis ($F(2,72)=6.32$, $MSE=0.61$, $p<0.01$). Vividness of imagery ratings rose from 5.69 after the first set of six cues to 6.25 after the second set, and 6.20 after the final set.

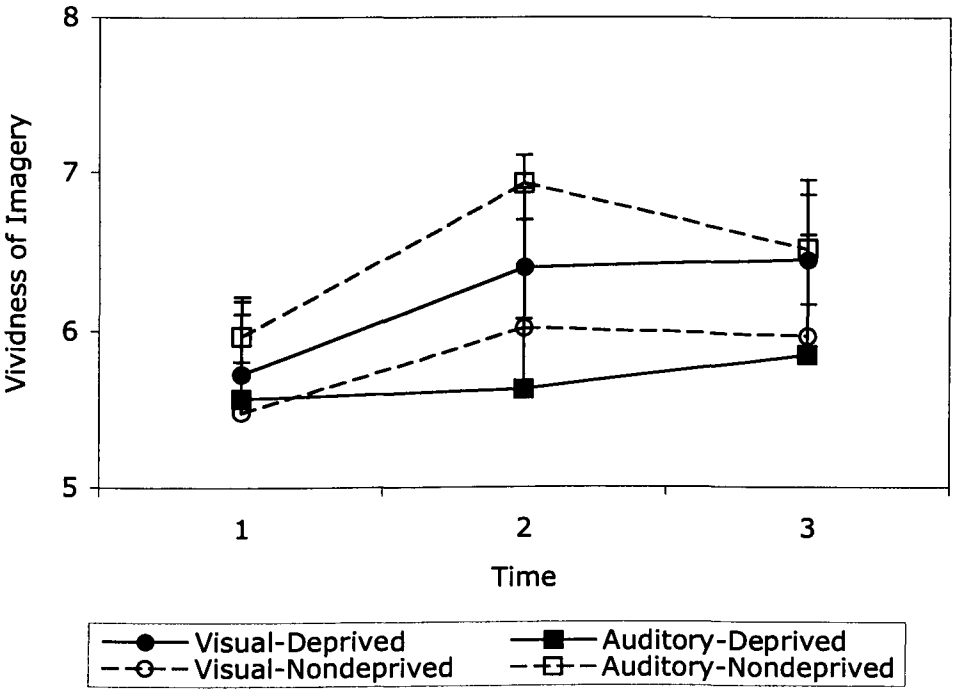

Figure 19: Ratings of imagery vividness during experiment 1 with errors bars indicating +1 standard error.

These results show that the changes in craving strength were not due to changes in mood and that the two imagery tasks were comparable in difficulty. To further examine any associations of mood and craving, change scores were computed for both variables by subtracting the Baseline score from the final score (after trial 18). Across the complete sample, there was a significant correlation ($r=-0.38$, $p<0.05$), with a positive change in mood being associated with a reduction in craving. An improvement of mood was associated with a reduction in craving. When the four experimental groups were examined separately, only the Visual imagery groups showed significant effects (deprived $r=-0.62$, $p=0.05$; non-deprived $r=-0.68$, $p<0.05$). No significant effects were found in the auditory imagery groups (deprived $r=-0.41$, ns; non-deprived $r=-0.30$, ns), possibly because of the absence of any changes in craving.

To examine any associations of vividness of imagery and craving, mean craving change scores were correlated with mean vividness scores across the three measurement points. For the sample as a whole, there was no relationship ($r=0.08$, ns). When the four experimental groups were examined separately, only the visual deprived group showed a significant relationship ($r=-0.67$, $p<0.05$), with low vividness ratings being associated with a larger reduction in craving.

6.3 Discussion

As intended, the combination of deprivation and craving script resulted in a higher level of craving than in the non-deprived conditions. Consistent with the predictions, concurrent auditory imagery had no significant effect on craving in either deprived or non-deprived groups. Deprived participants who performed the visual imagery task showed an immediate reduction in their craving for cigarettes, and they finished the experiment with the lowest rating of the four groups. The effects were not owing to a

differential impact of the imagery tasks on mood, nor to a difference in vividness of images in the two modalities. These results are consistent with the assumptions within the EI theory that there will be greater interference with craving-related imagery under conditions where the same limited-capacity working memory component (in this case, the visuo-spatial sketchpad) is recruited for another concurrent task. In other words, the disruption of craving is not simply a matter of distraction by any concurrent task, but rather by tasks that specifically target the underlying cognitive components of craving.

Low levels of craving and, consequently, no effect of concurrent imagery task were expected in the non-deprived groups. The mean baseline scores (4.12 for the Auditory group, 3.75 for the Visual group) for the non-deprived groups supported these assumptions. These values represent neutral responses on the QSU scale. Surprisingly, non-deprived smokers who completed the visual task showed a progressive increase in craving ratings across the experiment, and ended the experiment with equivalent craving to the deprived auditory group. No current theory of craving would predict that unrelated imagery would evoke smoking-related craving. The auditory images did not have this effect, so the result was not owing to smoking deprivation during the experiment itself. One possible explanation following from the EI theory is that the visual task directed attention towards visual imagery. In the absence of significant smoking deprivation, fleeting smoking-related image fragments may not normally have resulted in elaborative cognitive processing and hence in craving. However, the increased attention to visual imagery may have increased the salience of the momentary smoking-related intrusions and increased the likelihood of their elaboration. This unexpected finding needs to be replicated and its basis explored further before we can be sure of its theoretical implications. The study should also be replicated using a more passive imagery task: The task used in this study was obvious to the participants and the

increase in salience of imagery might have lead to an awareness of smoking related imagery that in turn increased craving in the non-deprived group.

Reductions in craving were associated with improvements in mood, and increased craving was linked to worsening mood. This result is consistent with the overall affective tone of craving being negative, despite the immediate positive response to craving-related images or thoughts. The vividness of task-related images was not associated with changes in craving across the sample as a whole. However there was a significant association within the visual deprived group. Interestingly, the participants with lower ratings of subjective vividness reported the largest decreases in craving. If this result can be replicated, it may reflect a greater degree of attention and manipulation of the image in working memory being required to meet the demands of the concurrent task, leaving less capacity for the smoking-related material to intrude into awareness.

The results of the study have important implications for the treatment and management of craving episodes in smokers who are attempting to quit. Not only do intensity and duration of craving episodes predict relapse to smoking (Shiffman et al., 1997), but also other data show that it disrupts other cognitive activities (Zwaan and Truitt, 1998) and (as shown in our study) craving is subjectively unpleasant. Therefore, techniques for reducing the occurrence, intensity and duration of craving episodes are important in improving both smoking outcomes and functioning during quit attempts. This study showed that craving that was induced by the combination of smoking deprivation and a multi-sensory urge script could be reduced by a concurrent visual imagery task. It would also be interesting to see if the same effects are observed when relying

exclusively on smoking deprivation to create craving, rather than augmenting deprivation effects with a multi-sensory craving induction.

If the findings of this study are valid, a concurrent visual imagery task will provide relief for smokers during the difficult initial abstinence period. This method avoids the conscious suppression of smoking-related thoughts, which is known to be an ineffective strategy (Palfai et al., 1997; Salkovskis and Reynolds, 1994). A concurrent task approach may also be applicable in other addictive disorders, although the modality of the task may need to change in cases where other sensory elements predominate.

7 Experiment 2 – Effect of visual noise tasks on cigarette craving

The imagery task used in the previous study was fairly obvious to the participants and involved active imagery, which might have increased the salience of imagery itself and in turn led to increase in smoking related visual imagery. This triggering of imagery salience may be avoided by using a less obvious, passive task known to interfere with visual imagery. The dynamic visual noise (DVN) task developed by Quinn and McConnell (1996a,b) is targeted specifically at visual processing and has been shown to interfere with visual imagery in word memory tasks, even when it is irrelevant to the task being carried out. Quinn and McConnell (1996a) have repeatedly demonstrated that DVN impairs verbal learning using the peg word mnemonic or a method of loci technique (Quinn and McConnell, 1996b). In contrast to the dynamic visual noise field, a static visual noise (SVN) display of black and white squares that do not change or "flicker" has no effect on imagery. Since there is no change occurring in the field, McConnell and Quinn (2000) argue that it can be ignored and causes no interference within the passive visual store when presented concurrently with the word memory task.

The constantly changing display of DVN does not capture the subjects' attention at any one time or direct their attention to any one place; it does not impose a general attentional load. This is shown by the minimal effect it has on learning by rote rehearsal tasks (Quinn & McConnell, 1996). The display contains squares that change randomly and continuously between black and white. The subjects watching the screen do not have to do anything in response to it and there are no patterns or details to detect (Smyth and Waller, 1998). Quinn and McConnell argue that DVN disrupts visual imagery by gaining obligatory access to the visuo-spatial sketchpad, or more specifically to a passive visual store in working memory. The interference is caused by the constantly

changing display of DVN, which causes the visual percept to be maintained in the store. The interference is thought to occur due to the changing aspect of the stimulus. The SVN displays do not change and are subject to decay in the passive visual store and, therefore, do not cause any interference.

Empirical evidence from studies run by Logie, Zucco and Baddeley (1990) showed mutual and selective interference between visual imagery and visual short-term memory. The visual span procedure used in their experiments showed that visual short-term memory is disrupted by secondary visual imagery, suggesting that it is involved in the generation and retention of visual images. Since visual imagery and visual short-term memory make demands on the same limited capacity stores, DVN should interfere with craving related imagery when it occupies the visual store. Baddeley and Andrade (2000) found that DVN reduced the subjective ratings of visual imagery vividness more than an articulatory suppression task. The effects of the processing of this dynamic visual noise should therefore be seen in other visual tasks where visualisation is important.

If visual imagery occupies the visuo-spatial sketchpad of working memory and is important to the craving episode, and DVN also occupies the same limited capacity store, then we would expect the dynamic visual noise to affect the cravings experienced by the participants by interfering with the craving related imagery in the visuo-spatial sketchpad.

The present study uses DVN as an interference task for smoking craving. This would allow us to further explore the underlying functions of craving. If DVN is able to suppress craving then it provides further support that craving involves visual imagery. Since the SVN task does not cause interference in the visuo-spatial sketchpad, it would

not be expected to have an effect on the craving ratings of smokers. This study looks at the effects of the dynamic and static visual noise tasks on the craving ratings of deprived and non-deprived smokers. The active visual imagery task used in Experiment 1 reduced the strength of craving in deprived smokers, though it also brought about an increase in craving ratings of non-deprived smokers. If this unexpected increase in the craving ratings of non-deprived smokers was caused by an overall increase in the salience of visual imagery, then using a task that does not use active visual imagery should overcome this effect. This study looks at whether a passive task has the same effects on the craving strength of deprived smokers. The DVN task would be expected to block craving related imagery and bring about a decrease in craving ratings and since DVN does not involve active visual imagery it should not have the same effect on non-deprived smokers and should not increase their craving ratings.

This study examined the impact of DVN and SVN on cigarette craving of continuing smokers and smokers who had been deprived from smoking for two hours prior to testing. The time of deprivation was reduced because quite a few smokers found the overnight period too long to wait without smoking. Craving intensity was expected to decrease when the groups were watching the DVN screens, while no change would be expected in the craving ratings when watching the SVN screens. As in the previous study, participants gave baseline ratings for both cigarette craving and mood, which were followed by further ratings after two blocks of visual noise task. In this study, the visual noise tasks were presented only once in this study because in experiment 1, the biggest effect of the tasks was seen during the first block of the imagery task. So it was expected that one presentation of the visual noise tasks would still have an effect on the craving ratings. The crossover design used here differs from the one used in the previous experiment; half the participants saw the DVN screen first and the rest started

off with the SVN screen. These were then switched around for the second block. This would allow further exploration of the effects of DVN. If DVN does decrease smoking craving, the crossover design would also show whether this effect is temporary interference or whether the craving ratings remain low even after the DVN is removed.

7.1 Method

7.1.1 Participants

The sample consisted of 46 participants and comprised of students and staff at the University of Sheffield recruited through Psychology Department notice boards. Ten participants were excluded from the sample because they did not appear to be answering the questionnaires correctly; they were ticking all the 7 (high score) boxes regardless of the response direction. Another two participants were excluded from the sample as they reported high emotional stress prior to beginning the experiment, leaving 34 subjects, 22 female and 12 male, in the final sample. Participants' age ranged from 19 years to 52 years with a mean age of 24 years. Participants smoked a minimum of 10 cigarettes a day. All participants received a honorarium of £2 for taking part in the study.

7.1.2 Measurement and Materials

The same questionnaires used in the previous study were used to measure craving strength (QSU; Tiffany and Drobes, 1991) and Mood levels (Diener and Emmons, 1984). The induction procedure used the same passages from the previous study (Tiffany and Hakenewerth, 1991).

The dynamic visual noise screen and the static field screen were presented to the subjects on an Apple iBook laptop. A static reproduction of the dynamic visual noise used in the study can be seen in Appendix F. The display took up the entire screen height; screen size 12 inches, 80 cells high and 80 cells wide with 10 pixels per cell and

was subject to a continuous on/off rate of change of 1000 cells per second. The static screen had the same properties with the rate of change set to zero cells per second. The field used by Quinn and McConnell was 320 x 320 pixels with each cell consisting of 4 x 4 pixels (80 x 80 cells) with a rate of change of 291 cells/sec. The display used in this experiment was larger and faster than the noise field used by Quinn and McConnell (1996). If the squares used in the display were substantially larger it might have reduced the flicker effect. However, we estimate that our display is only approximately 50% larger than the one used by Quinn and McConnell and the faster flicker rate used in this study should have offset the effects of the larger display size. The participants sat approximately 80 cm from the screen and the display subtended a visual angle of 0.22 degrees.

7.1.3 Procedure

The participants were randomly assigned to each of the four experimental groups. Those in the deprived condition were instructed not to smoke any cigarettes or use any tobacco products or nicotine replacement products for two hours prior to testing. Participants in the non-deprived condition were not given any instructions about their smoking before the study and they continued to smoke as normal. All participants were again tested between 1400 and 1800 hours to minimise effects of diurnal variations in craving (West and Schneider, 1987).

On arrival, participants first completed a smoking history questionnaire. They then completed the urge induction procedure; the deprived group read a passage containing a smoking situation whilst the non-deprived group read a passage about washing dishes.

Participants then completed the QSU scale and the Mood scale to give baseline ratings for both craving and mood. This was followed by the interference tasks. The

participants watched the computer screen where the dynamic visual noise task and the static visual noise task were presented. The participants in the D-S condition were first presented with the dynamic visual noise screen followed by static visual noise. The participants in the S-D condition were first presented with the static visual noise screen. These were presented to the subjects in 15 second sets with a 5 second interval between each presentation, to keep the presentation pattern as similar to the pattern of the imagery cue presentation in the previous experiment. There were 6 presentation sets in all, which took a total of 2 minutes. The participants were instructed to watch the screens at all times and keep the display in focus.

The participants then completed the Craving and Mood questionnaires again. They then watched the computer screen again. This time the screens were switched over and the participants in the D-S condition were presented with the static visual noise screen and the participants in the S-D the dynamic visual noise screen. Again the screens were presented to the subjects in 15 second sets with a 5 second interval between each presentation. After the 6 presentations the participants completed a final set of QSU and Mood questionnaires. They were then debriefed and paid for their participation in the study.

7.2 Results

Ratings of craving strength and mood were taken three times for each participant, at the start of the experiment to provide baseline ratings, and then following each block of visual noise presentations. ANOVAs were conducted on the measures of craving and mood with *Deprivation* group (deprived v non-deprived) and *Order* (D-S v S-D) as between subjects variables, and *Time* (Baseline, time 1, time 2) and *Interference* (DVN v SVN) as within subjects variables.

At Baseline, both the deprived groups reported higher levels of craving than the non-deprived groups (*Deprivation* at Baseline: $F(1,30) = 11.16$, $MSE = 1.14$, $p < 0.01$). There was no main effect of order ($F(1,30) = 1.39$, $MSE = 1.14$, ns) although baseline craving for the deprived D-S was somewhat higher than deprived S-D. There was also no interaction of *Deprivation* x *Order* ($F(1,30) = 1.44$, $MSE = 1.14$, ns). The changes in craving ratings during the experiment can be seen in Figure 20.

The craving means of the deprived group who had DVN presented to them first dropped from 5.53 to 5.12 after the DVN presentation. The two groups who had the SVN screen remained fairly level with a slight increase in the craving ratings. A larger increase was seen in the non-deprived group who watched the DVN screen. A similar result was observed in the previous experiment where the visual imagery task increased the craving ratings of non-deprived smokers.

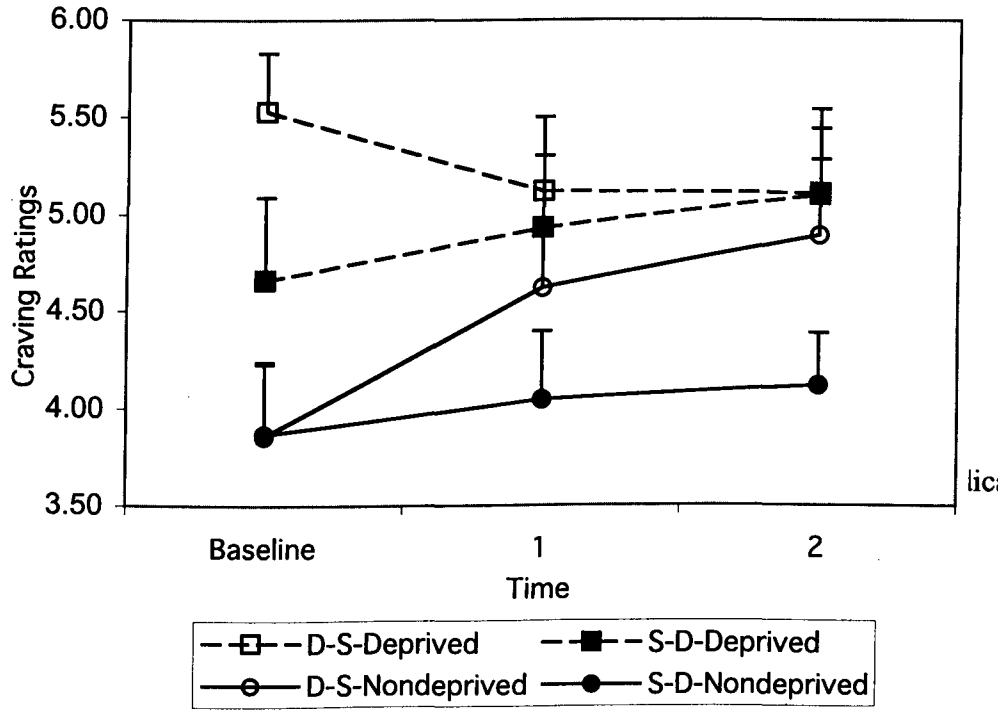

Fig licating

Change of craving scores was calculated between baseline and time 1, and between time 1 and time 2. The analysis carried out on the change of craving scores did not show a

significant interaction between *Deprivation*, *Order* and *Interference* $F(1,30) = 0.88$, $MSE = 0.98$, ns).

An ANOVA was carried out on the change score for the first block of visual noise presentation looking at the effects of *Deprivation* and *Interference*. Though the main effects of *Deprivation* and *Interference* were not significant, there was a significant interaction between the two factors ($F(1,30) = 4.40$, $MSE = 0.78$, $p < 0.05$). The mean craving scores of the two groups who watched the SVN screens did not change much, though there was a slight increase in their craving scores. The mean craving ratings of the deprived group who watched the DVN screen was seen to decrease while an increase in mean craving ratings was observed in the non-deprived group who watched the DVN screen (see Figure 21). Planned comparison analysis carried out on the deprived group showed that there was no significant differences between the SVN and DVN conditions ($F(1,30) = 0.10$, $p > 0.05$, ns). Post-hoc tests showed that there were no significant differences between the DVN and SVN conditions in the non-deprived group (mean difference = 0.59, $p > 0.05$).

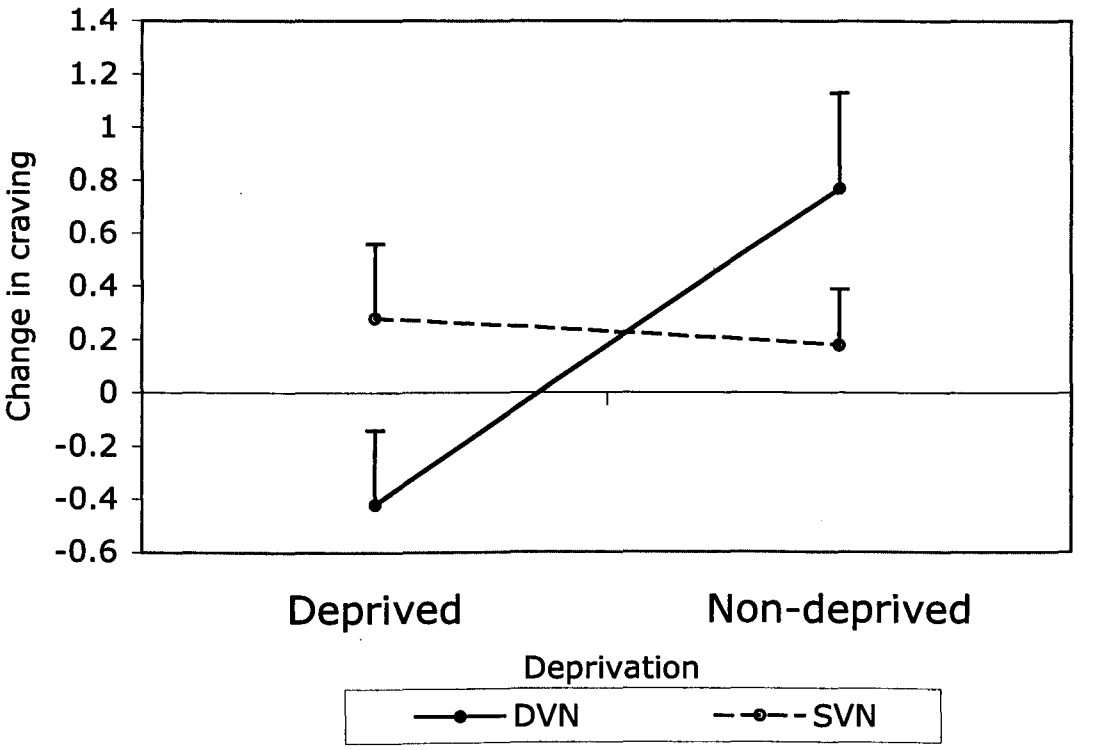

Figure 21: Change in craving scores between baseline and time 1.

The analysis carried out on mood ratings failed to show any effects of *Deprivation*, *Interference* or *Order* so changes in craving cannot be attributed to changes in mood between the groups. Mood did show an effect of time, and changes of mood during the experiment can be seen in Figure 22.

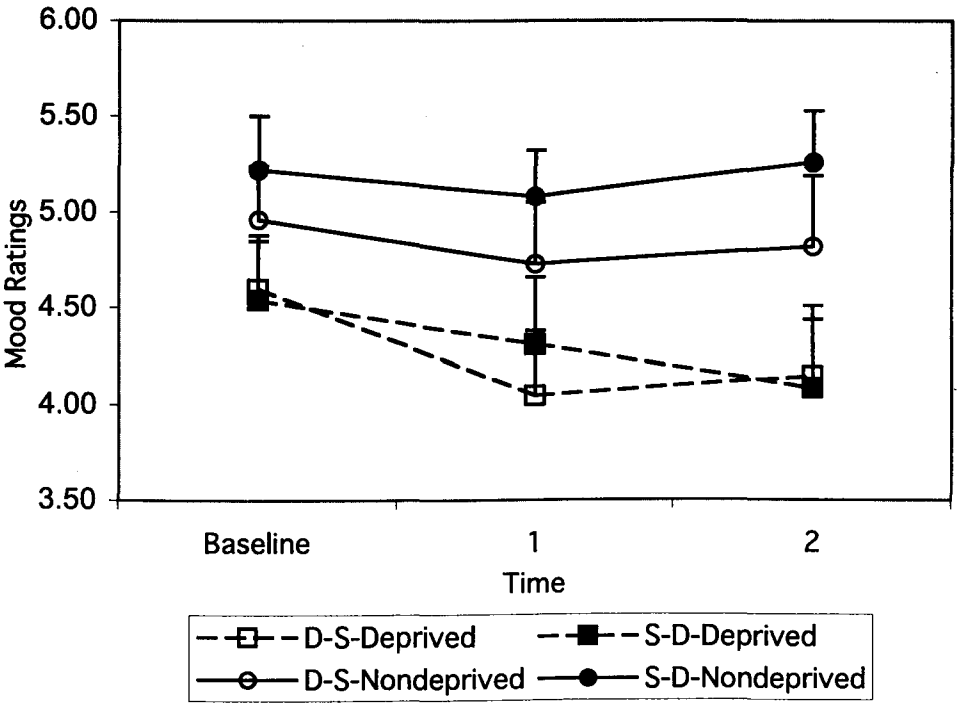

Figure 22: Mood ratings during experiment 2 with errors bars indicating +1 standard error.

The mood ratings of the groups who had SVN as the first visual noise presentation, were fairly constant throughout the study, while a decrease in mood scores in the groups that had DVN as the first visual noise presentation. The changes in mood seen in the experiment were not statistically significant.

7.3 Discussion

The combination of deprivation and urge induction scripts resulted in higher levels of craving in the deprived smokers than the non-deprived smokers. No effect of order was seen, which showed that the subjects were randomly allocated in the separate conditions. After the first visual noise presentation in the first experimental block, the deprived participants who watched the DVN experienced a slight decrease in their strength of craving whilst the SVN task did not appear to have any effect on the craving ratings of smokers. A passive task such as dynamic visual noise appears to reduce craving ratings in deprived smokers. Since DVN is known to interfere with visual imagery, the results are consistent with the hypothesis that craving for cigarettes involves visual imagery. This is consistent with the predictions made according to the EI theory and suggests that the disruption of craving is caused by tasks that specifically target the underlying cognitive concepts of craving. Though the DVN managed to reduce mean craving ratings of the deprived smokers, it did not have as large an effect as the visual imagery task in the previous experiment. In Experiment 1, the deprived smokers who completed the visual imagery task finished the experiment with lower craving ratings than any of the other groups. However, this is not seen in the DVN group in this study; though DVN reduces craving in deprived smokers, they still finish the experiment with higher craving ratings than the other groups. The non-deprived smokers who watched DVN and experienced an increase in their craving finished the experiment with the same craving ratings as the deprived smokers.

The rise in craving scores of the non-deprived smokers who had the DVN task first is an unexpected effect. A similar increase was observed in the previous experiment where the visual imagery task increased the craving ratings in non-deprived smokers. The explanation suggested for the experiment 1 was that the visual imagery task might have

increased the salience of visual imagery, which might have in turn increased craving related imagery. However, the use of DVN in this experiment was intended to avoid this effect because DVN interferes with imagery without stimulating the participants' awareness of imagery. The increases in smoking craving in the non-deprived group cannot be due to the subjects completing the Questionnaires of Smoking Urges. Shadel, Niaura and Abrams, (2001) investigated whether completing a craving questionnaire promoted increased smoking craving. Their results indicated that the QSU did not promote increases in smoking craving. The changes in craving scores therefore are not due to the completion of the questionnaires and, because a similar effect is seen in the non-deprived smokers when using visual imagery and DVN, it can be assumed that the increase in craving is not due to an overall awareness of visual imagery. This effect needs to be explored further before any conclusions can be made.

The results observed in the second experimental block are also unexpected. The DVN task was expected to reduce the cravings of deprived smokers. The effects of DVN on craving strength in the second block differed from the effects observed in the first experimental block. Though a decrease in the cravings of deprived smokers was seen in Block 1 of the experiment, a similar effect was not observed in the second block after the tasks were switched over. The static visual noise task continued to have no effect on the craving strength of deprived and non-deprived smokers, but the effects of the DVN task on deprived smokers were inconsistent across the two experimental blocks. The effects of DVN on non-deprived smokers were also inconsistent. The crossover design used in this experiment may be responsible for the inconsistencies of the results.

The visual noise tasks were chosen for this experiment because they were less obvious and more passive. However, since the participants did not have anything to do during

the experiment except watch the screen for two minutes, they might have found it quite boring. Boredom might have led to an increase in craving related thoughts and caused the variation in the results. If they were not really watching and focusing on the screens, DVN may not have had the desired effect on their cravings. To maintain their collaboration during the experiment the noise tasks might have to be paired with a more active task that is known not to have an effect on craving.

More information about tasks that block craving related imagery is important for the development of management techniques. In the first experimental block DVN reduced the craving strengths in deprived smokers. However, due to the inconsistencies in this experiment, the study should be replicated before any firm conclusions can be drawn about the effects of DVN on craving.

8 Experiment 3 – Replication of effects of imagery and DVN on craving

Experiment 1 tested whether the subjective experience of craving was mediated by mental imagery. The results observed in that study showed that a concurrent task that loaded onto the cognitive processes thought to be involved with generating and maintaining an image of a craved substance reduced the cravings. The visual imagery task used in that study was seen to reduce the craving ratings reported by the participants, whilst the auditory imagery task had no effect on the craving ratings. The DVN tasks in Experiment 2 also reduced craving in deprived smokers while SVN had no effect. The visual imagery task and DVN both increased the craving ratings reported by the non-deprived smokers.

The results observed in Experiment 2 were not consistent as the effect of DVN on craving differed between the two experimental blocks. The inconsistent results could be due to the fact that the subjects are getting bored watching the DVN and SVN screens. They did not have anything else to do during the two minutes of visual noise presentation and watching these screens could be making their minds wander which might have increased their craving related thoughts. The present study was carried out to further investigate the effects of DVN on craving but, this time, to remove boredom as a factor, the subjects had to complete an imagery task used in experiment 1 whilst looking at the visual noise screens.

The present study allows replication of the main results of the Experiment 1. The visual imagery task is used again to see if it brings about a decrease in craving ratings of deprived smokers, and to see if it also causes an increase in the cravings of the non-deprived smokers. It also further investigates whether DVN, a passive task blocks visual imagery, can also bring about a reduction in craving. This is accomplished by pairing

DVN with the auditory imagery used in the previous experiment and pairing the visual imagery task used previously with SVN, which has no effect on imagery. Thus, both conditions used in this study had a visual noise and imagery component. In the visual imagery + SVN (VI+SVN) condition the imagery is predicted to be effective in reducing craving, and in the auditory imagery + DVN (AI+DVN) condition the noise is predicted to be effective in reducing craving.

This study, then, examined the impact of both DVN and visual imagery task on the cigarette craving of continuing smokers and smokers who had been deprived from smoking for two hours prior to testing. As in the previous studies, participants gave baseline ratings for both cigarette craving and mood, which were followed by further ratings after each of three blocks of six imagery tasks. This experiment provides an increase in the visual noise presentation than in Experiment 2. Participants in this study would watch the noise screens for three blocks in comparison to one block of visual noise presentation in Experiment 2. Craving intensity was expected to decrease in both deprived groups, which would be due to the DVN in the AI-DVN group and due to the effect of the visual imagery task in the VI-SVN group. The non-deprived VI-SVN group can replicate the unexpected increase in craving seen in the non-deprived visual group in the Experiment 1, while the non-deprived AI-DVN group can replicate the increase in the non-deprived DVN group in Experiment 2.

8.1 Method

8.1.1 Participants

The sample consisted of 40 participants, 24 male and 16 female, and was made up of the students and staff at the University of Colombo, Sri Lanka, recruited through Psychology Department notice boards. Participants smoked a minimum of 10 cigarettes

a day. The participants had a mean age of 31:11 years, and had started smoking at 11.4 years. They smoked a mean of 15 cigarettes a day and had been smoking regularly for a mean of 17:2 years. Seventy-five percent had previously tried to quit, and 75% were presently trying to cut down on their smoking. All participants received an equivalent payment of £2 in local currency (Rs. 300) for taking part.

8.1.2 Measurement and materials

The same questionnaires used in the previous experiment were used in this study to get measures for craving strength (QSU; Tiffany and Drobes, 1991) and Mood (Diener and Emmons, 1984) and smoking history.

The same visual and auditory imagery stimuli from the tasks used in the previous experiment (Baddeley and Andrade, 2000) were paired with the SVN and DVN displays respectively.

The urge induction procedure also repeated the passages used in the previous study.

The dynamic visual noise screen and the static field screen were presented on an Apple iBook laptop. Participants were seated approximately 80 cm away from the screen. The display took up the entire screen height; screen size 12 inches, 80 cells high and 80 cells wide with 10 pixels per cell and was subject to a continuous on/off rate of change of 1000 cells per second. The static screen had the same properties with the rate of change set to zero cells per second.

8.1.3 Procedure

Participants were randomly assigned to each of the four experimental groups, such that ten were in each group. Those in the deprived condition were asked not to smoke any cigarettes, or to use tobacco products or nicotine replacement products, for two hours

before they were tested. Participants in the non-deprived condition were not asked to abstain from smoking before the study. All the participants were tested between 1400 and 1800 hours to minimise diurnal variations in cravings (West and Schneider, 1987).

The participants first completed a questionnaire describing their smoking history. They were then given one of the imaginal urge or neutral passages constructed by Tiffany and Hakenewerth (1991), which they were asked to read to themselves while imagining the described scenario.

Participants then completed the QSU Factor 1 scale and the Mood Scale to give the baseline ratings of craving and mood. This was followed by the imagery task. As before, half of the participants in the deprived condition were assigned to either the auditory imagery or visual imagery condition. The experimenter read out each cue and the participants were asked to imagine the cue whilst looking at the computer screen. The participants in the visual imagery condition looked at a static visual noise screen (VI-SVN) and the participants in the auditory imagery condition looked at the dynamic visual noise (AI-DVN) screen. The participants looked at the screens during the 10-second imagining period. Apart from this, the experimental procedure was the same as in the Experiment 1.

8.2 Results

Ratings of both craving strength and mood were taken four times for each participant, once at the start of the experiment to provide baseline ratings, and then following each of the three blocks of imagery trials. The mean vividness rating was computed for each block, so that each participant had three ratings for imagery vividness. ANOVAs were carried out on the measures of craving strength, vividness of imagery and mood scores, with *Deprived* group (deprived v non-deprived) and *Imagery* group which now

represented the combined imagery and visual noise tasks (VI-SVN v AI-DVN) as between subject variables, and *Time* as a within subject variable (Baseline, blocks 1, 2 and 3 for craving and mood; blocks 1, 2 and 3 for vividness).

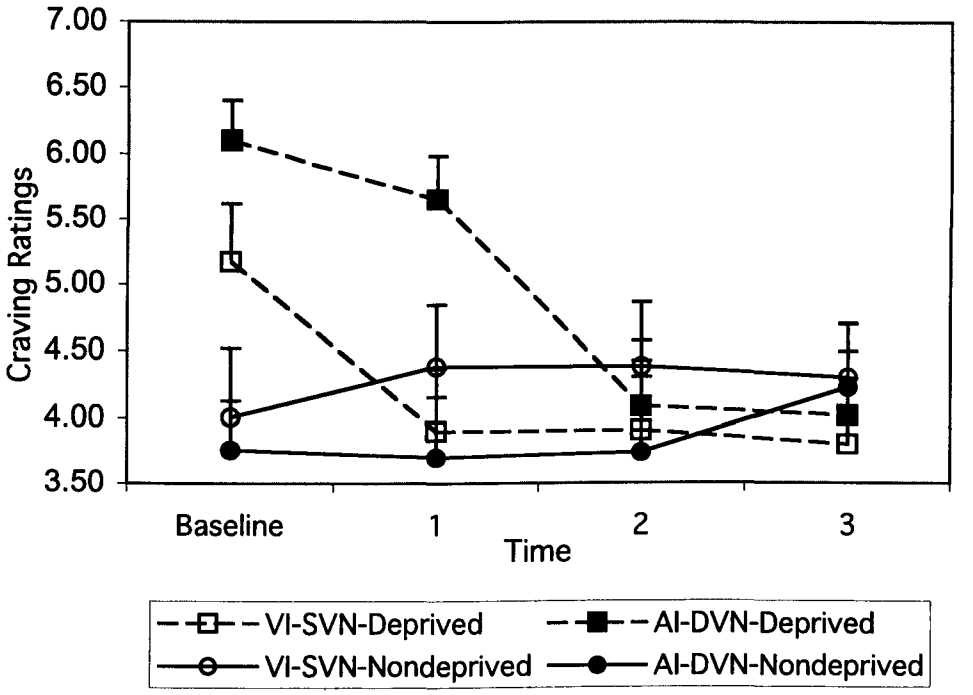

Figure 23: Ratings of craving strength during experiment 3. AI-DVN = Auditory Imagery plus Dynamic Visual Noise; VI-SVN = Visual imagery plus Static Visual Noise with errors bars indicating +1 standard error.

Figure 23 shows variation of craving ratings with time for the four experimental groups. The craving scores showed a significant three-way interaction between *Deprivation* group, *Imagery* group and *Time* ($F(3,108) = 3.68$, $MSE = 0.57$, $p < 0.05$).

The graph shows that at baseline, both deprived groups displayed higher levels of cravings than the non-deprived groups (effect of deprivation at Baseline: $F(1,36) = 17.5$,

MSE = 1.76, p<0.001). The results also showed that imagery groups did not differ in their craving. (Effect of Imagery at Baseline: $F(1,36) = 0.66$, *MSE* = 1.76, ns)

The craving mean of the visual imagery-deprived group dropped from 5.17 to 3.80 after the first block of imagery cues and remained low throughout the experiment. The largest decrease in the AI-DVN deprived group, however, was seen after the second block of imagery cues: the mean for the craving ratings had dropped from 6.10 at baseline to 4.09. However the participants had to be reminded to watch the screen during the imagery tasks. The two deprived groups finished the experiment with lower craving ratings than the non-deprived groups. The two non-deprived groups' craving ratings remained fairly level throughout the experiment (VI-SVN non-deprived group mean = 4.27; AI-DVN non-deprived group mean = 3.85). These represent fairly neutral responses on the craving scale.

Given the significant three-way interaction, separate one-way repeated measures ANOVAs were carried out for each deprivation and imagery group with time as the within subjects factor. The analysis confirmed that there were no significant effects of time on the craving ratings reported by the participants in the non-deprived condition (VI-SVN: $F(3,27)= 0.49$, p=0.69, ns; AI-DVN: $F(3,27)=1.86$, p=0.16, ns). Significant effects of time were observed for both deprived groups (VI-SVN: $F(3,27) = 7.98$, p<0.05; AI-DVN: $F(3,27) = 15.71$, p<0.001).

The vividness of imagery ratings did not show any effects or interactions of deprivation group or imagery group. The changes in vividness ratings for the four experimental conditions can be seen in Figure 24

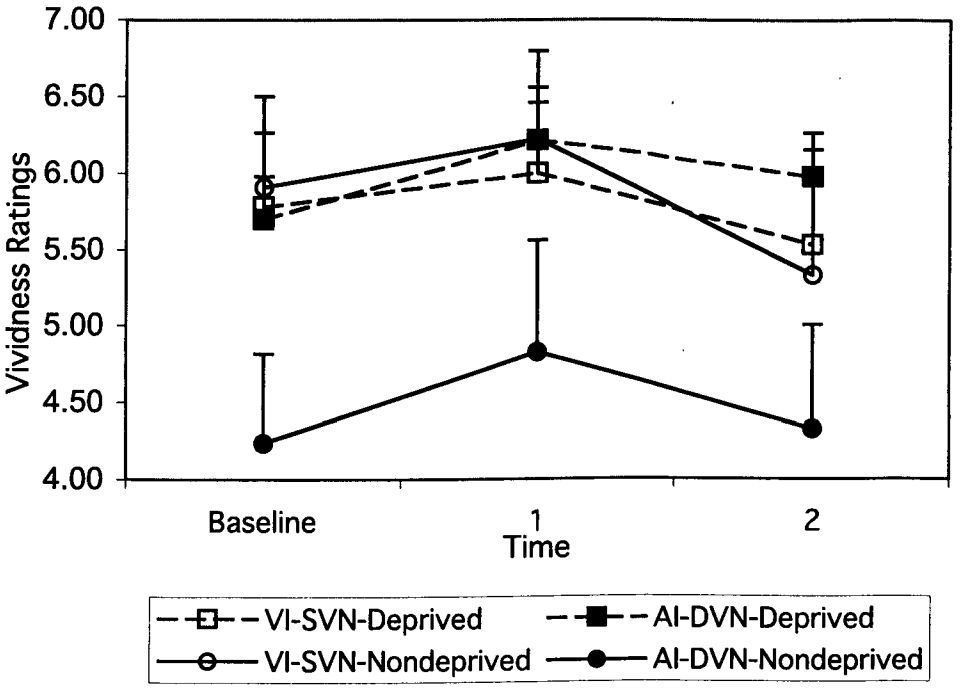

Figure 24: Imagery vividness during experiment 3 with errors bars indicating +1 standard error.

To investigate any associations of vividness of imagery and craving, mean change-craving scores were correlated with mean vividness scores across the three measurement points. There was no relationship in the sample as a whole (r= -0.13, ns), or when looking at the four experimental groups separately (VI-SVN deprived: r= -0.02, ns; AI-DVN deprived: r= 0.28, ns; VI-SVN non-deprived: r=0.36 ns; AI-DVN non-deprived: -0.42, ns).

Mood ratings did not show any significant effects or interactions of urge group, imagery group or time (see Figure 25). The AI-DVN non-deprived group however shows an initial decrease in mood between baseline ratings and the first block of the imagery trial. Separate one-way repeated measures ANOVAs were also carried out on the mood data; the only significant effects were observed in the AI-DVN non-deprived group which showed a significant effect of time $F(3,27) = 3.58$, $p < 0.05$.

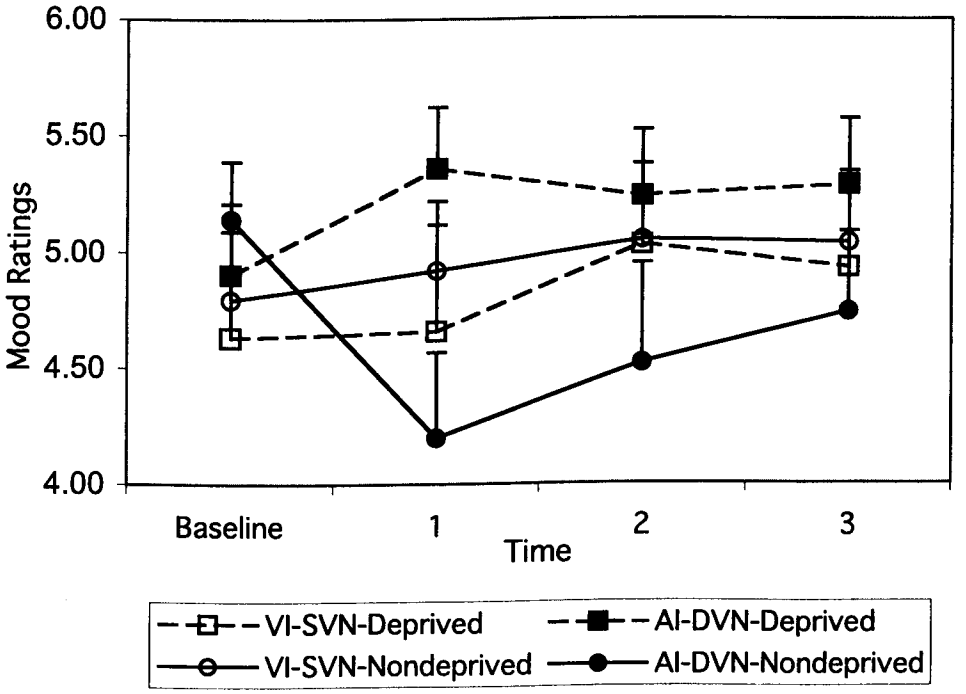

Figure 25: Mood ratings during experiment 3 with errors bars indicating +1 standard error.

These changes in mood do not seem to have an effect in the changes in the craving ratings as the changes in the mood ratings do not have corresponding changes in the craving ratings as can be seen in the graphs above. Ratings for mood were taken to see if the two imagery tasks were altering the mood states of the participants and thereby bringing about a change in their cravings. However, though there appear to be fluctuations in the mood ratings these ratings do not seem to be responsible for the changes in craving ratings.

To further investigate any interactions of mood and craving, change scores were calculated for both variables by subtracting the baseline score from the final score (after the eighteen cues). Positive scores indicate an increase in craving and a more positive mood. None of the groups showed a significant relationship between change in mood and change in craving scores. (VI-SVN deprived = -0.22, ns; VI-SVN non-deprived= 0.44, ns; AI-DVN deprived = 0.08, ns; AI-DVN non-deprived = -0.22, ns).

8.3 Discussion

The deprivation combined with the craving induction scripts resulted in higher levels of craving than in the non-deprived conditions. The deprived participants in the VI-SVN group showed an immediate reduction in their cravings for cigarettes, which replicated the findings that were observed in the previous study. In addition, the results also show a similar reduction in the cravings of the deprived participants in the AI-DVN group, but later, after the second block of DVN presentation. Both groups finished the experiment with lower craving ratings than the non-deprived groups. Since Experiment 1 showed that the auditory imagery task had no significant effect on craving, the changes in the craving ratings in the AI-DVN deprived group can be attributed to the effects of the dynamic visual noise task, which reduced craving in the first block of

Experiment 2. The analysis carried out on the vividness of imagery data suggests that the changes in craving were not related to the vividness of the cued images. Furthermore, the results from the analysis of mood suggest that the concurrent task manipulations affected craving directly and not indirectly through effects on mood. The results observed provide further support for the assumptions made within the EI model that interference with cravings is caused by tasks, which target the underlying cognitive components of the craving experience. Interference would be greatest when the same limited-capacity working memory component required for craving imagery is used for a concurrent task.

The two tasks used in the study were not expected to have an effect on the low levels of cravings reported in the non-deprived conditions. The mean scores for these two groups represent relatively neutral responses on the QSU scale (VI-SVN = 3.67 and AI-DVN= 3.32) The earlier studies showed a progressive increase in the craving experienced by the non-deprived smokers who undertook the visual imagery or DVN task. This was a surprising finding, but was not replicated in this study, and therefore may have been a chance finding. The non-deprived smokers did not show any changes in their craving ratings throughout the experiment; their ratings remained constant.

The three-way repeated measures ANOVA carried out on the mood data also did not show any significant results. There were slight fluctuations in the mood ratings throughout the experiment, though none of these changes proved significant. There was an overall increase in mood at the end of the experiment in most of the groups, associated with a decrease in the craving ratings. Since there were no significant changes in mood, any changes observed in the craving ratings would be due to the effect of the tasks.

However, the pattern of mood change in the AI-DVN non-deprived group was different to those seen in the other experimental conditions. The one-way repeated measures ANOVA showed a significant decrease in the mood at the start of the experiment (between baseline and Time 1) and then showed a gradual increase in mood in the following blocks. The other groups showed a gradual increase in mood across the experimental blocks, though these changes did not prove to be significant.

Changes observed in the vividness of imagery ratings also did not prove to be significant in the analysis carried out on the data. This shows that the changes in vividness were not on the cravings experienced by the participants. The vividness of imagery ratings of the participants in the AI-DVN deprived group appeared to be lower than the other groups. This, however, it did not prove to be a significant difference.

The results observed in this study provide us with another technique for reducing the intensity of a craving episode. Experiment 1 showed that a concurrent visual imagery task was able to reduce craving induced by urge scripts combined with smoking deprivation. Though inconsistent results were observed in Experiment 2, the present study replicated the effect of the visual imagery task; as well as showing that DVN has a similar effect. The effects of DVN may not have been seen in Experiment 2 because there was only one block of visual noise presentation as the effect of DVN in this study is observed mainly after the second block. Cravings are an unpleasant experience known to disrupt other cognitive activities, so these methods of reducing the craving intensity are important in the management of addictive disorders.

9 Experiment 4 –Effectiveness of visual imagery tasks as an intervention technique

The previous studies (Experiments 1 – 3) were aimed at reducing the craving by identifying tasks that blocked craving related imagery. The results observed suggest that at least with smoking, visual imagery appears to be an important aspect to the craving. The results observed in those studies have shown that the interference is greatest and most effective when the task targets the underlying cognitive components of the craving experience itself. The visual imagery task and the dynamic visual noise task, both of which occupy the same limited-capacity working memory component (visuo-spatial sketchpad) have been shown to reduce cravings for smoking, at least providing DVN is paired with an attention demanding task so that the overall task is less passive.

Further research is necessary to look at the effects of these methods on smoking behaviour, to see whether the visual imagery task has a temporary effect on smoking. The results from the previous studies show that we can reduce the reported strength of craving. However, there is no evidence that this causes smokers to smoke less. Though many addicts identify craving as the main reason for their relapse, the relationship between craving and behaviour is relatively weak. Though some models attribute a causal role to it (EI theory, Kavanagh et al., under review; Niaura et al., 1988), many others regard craving as an epiphenomenon; a reason given for relapse behaviour, but not the actual cause of it (Tiffany, 1990). Tiffany's review of cue reactivity studies showed that laboratory-based studies have provided little evidence for the assumption that craving and consumption are closely related. Furthermore, Tiffany and Conklin (2000) argue that laboratory studies of craving and use do not display a level of consistent, systematic association. According to them, if craving is at the motivational

core of alcoholism, then any incident of relapse should be preceded by an episode of craving. They say that, though abstinent alcoholics complain about the difficulties in coping with craving when they are trying to remain sober, relapsed alcoholics rarely identify craving as a major recipient of their relapses. As an example, they report the results of a survey of 300 alcoholics by Miller and Gold (1994) where fewer than 7% of the sample identified craving as a primary reason for their relapse. They also argue that similar results have been observed in studies of other substance use (Marlatt and Gordon, 1985; Ludwig, 1989; Heather, Stallard and Tebutt, 1991). To explain this weak relationship between craving and relapse, some researchers (Miller and Gold, 1994; Robinson and Berridge, 1993) suggest that craving operates on an unconscious level. They argue that if consumption is driven by unconscious processing, then it can not be expected that self-reports of craving, which are driven by conscious processing, should be closely related to measures of consumption (Tiffany and Conklin, 2000). More recent work by Robinson and Berridge (2000) attribute a greater role to conscious processes in craving

The inability to cope with cravings is often the reason given by smokers when asked why they continue to smoke (Pickens & Johanson, 1993). Almost 80% of current smokers try to give up smoking at some point and cigarette smoking is the leading preventable cause of morbidity and mortality (Milch, Edmunson, Beshansky, Griffith and Selker, 2003). Smokers have been reported to experience desires and urge to smoke even after 10 years of successful abstinence (Fletcher and Doll, 1969). Craving has also been shown to be an important factor in the maintenance of dependence and in producing relapse even after the completion of psychological treatment (Killen et al., 1991). Killen and colleagues examined the factors associated with craving in smokers over an 8-week treatment period. Their results showed that craving measures were

associated with dependence and treatment outcomes. They argued that their findings suggest that craving is an important factor in maintaining dependence and producing relapse.

The EI theory attributes a causal role to craving. The authors suggest that models that describe craving as an epiphenomenon do not provide a complete explanation of the full range of triggers and cognitive processes involved in the experience. The theory argues that craving has a strong motivational force and is moderated by other variables. They acknowledge that substance use behaviour is not always caused by craving and that the presence of a craving episode does not always bring about consumption. A cognitive model, which acknowledges all the factors associated with craving, may be used in developing successful treatment techniques. The attribution of a central role to craving in addiction can lead to treatments that are aimed at decreasing craving and thereby decreasing the motivation for the substance use.

The visual imagery task was successful in reducing craving ratings in deprived smokers in the laboratory. Though the task has an effect on the subjective craving experience, it might not be able to influence the smoking behaviour of smokers. Behaviour would be affected by other factors (environment, mood, etc.) and even though the task is able to reduce the craving the smoker is experiencing, it might not be able to work effectively each and every time the smoker uses the task outside the laboratory setting. However, if the visual imagery task is able to reduce smoking, then it could be developed into a potentially powerful treatment intervention. Further investigation of the effects of the task on smoking behaviour itself is necessary before it can developed into a successful intervention technique.

This study investigates whether the visual imagery task could be used to influence smoking behaviour outside the laboratory setting and compares the effects of both the visual and auditory imagery as an intervention technique for smokers. Since the visual imagery task has been shown to suppress smoking cravings, it is expected to help them withstand cravings without resorting to smoking, reducing the number of cigarettes smoked. This should help them in quitting smoking. The participants were asked to record the number of cigarettes that they smoked each day. Instead of relying only on self-reported smoking, smoking levels were also estimated by measuring the amount of carbon monoxide (CO) in the participants' breath. The amount of CO in expired alveolar air after breath holding is well correlated with carboxyhaemoglobin levels (Irving, Clark, Crombi and Smith, 1988). Following inhalation, CO displaces oxygen in the blood to form carboxyhaemoglobin. Thus, heavier smokers would have higher levels of CO in their breath. Measuring breath CO levels provides a convenient, non-invasive measurement of cigarette smoking.

The participants were recruited for the study through an email about quitting smoking. To make sure that they received something that would help them in the quitting process even if the tasks used in the study had no effect, the participants were given an information pamphlet about giving up smoking from the NHS Smoking Helpline at the start of the study. There is a substantial body of research in support of the efficacy of brief interventions for alcohol and drug related problems especially alcohol and tobacco (Roche and Freeman, 2004). The pamphlet included information about the benefits of giving up smoking as well as a few suggestions about how to stop. After completion of the study, the participants were given a booklet from the NHS about giving up smoking. The booklet contained more detailed information about giving up, as well as hints and activities designed to help the smoker to quit. Thus, all participants might be expected

to show a reduction in smoking and the contrast of empirical interest is whether the visual imagery task supports an additional reduction, compared to the auditory imagery task.

9.1 Method

9.1.1 Participants

The sample consisted of 37 smokers who wanted to give up smoking. Eight participants failed to complete the study, giving a dropout rate of 21%, leaving 29 participants, 19 female and 10 male, in the final sample. Participants were recruited through the Sheffield University Volunteer emailing list, and consisted mainly of university staff. Age ranged from 21 to 59 years with a mean age of 35 years and 3 months. They smoked an average of 11 cigarettes a day and had been a regular smoker for 16.8 years.

9.1.2 Materials and Measurement

All the participants received an Information pamphlet from NHS "Need help giving up smoking" about smoking at the start of the experiment. On completion they received a booklet from the NHS called "Giving up for Life"

They were also given a set of imagery task cue cards containing either visual or auditory stimuli. Each card had 6 cues drawn from the set of 18 cues used in experiment 1 and 3. Each pack had 80 different cards.

The number of cigarettes smoked each day was recorded in Smoking diaries.

Carbon monoxide levels at the start and in between each phase of the study were recorded using an EC50 Micro III smokerlyzer from BedFont Instruments.

The subjects also filled smoking history forms, the Fagerstrom test of Nicotine Dependence (FTND – see Appendix G).

9.1.3 Design

The participants were matched into pairs according to their smoking history and then randomly allocated to one of the two imagery conditions. The dropouts were replaced with subjects who signed up for the study later. The new pairs were also matched on smoking history.

The study consisted of three phases, a baseline-monitoring phase, a treatment phase; either visual or auditory, and a final post-treatment monitoring phase. Each participant completed each phase of the study.

The independent variable of imagery condition had two levels, visual and auditory imagery. The dependent variables were the number of cigarettes smoked during each week and the carbon monoxide levels. A non-imagery condition was not included in the study owing to the problems in recruiting enough participants for a non-imagery control group.

9.1.4 Procedure

Baseline Week: - The subjects came into the department at the start of the study to get their instructions for the first phase of the study. They completed the consent forms, smoking history forms, the FTND and their carbon monoxide levels were recorded.

Each participant was given an information pamphlet from the NHS called "Need Help Giving Up Smoking". They were asked to keep a record of the number of cigarettes they smoked each day in a smoking diary for six days. They were advised to fill the diary out before they go to bed as the last thing they do so that they could have an accurate account of the number of cigarettes they smoked during the day.

Mid-week Phone Call: - The participants were rung up in the middle of the week to remind them when they were to attend the next experimental phase, and to see how they were getting along with the study. This was intended to reduce dropouts.

Treatment Week: - The participants brought in their smoking diaries from the previous week and their carbon monoxide levels were recorded. They received instructions on how to use the imagery technique and were asked to practise the imagery technique a few times, until they had some idea of how long they should imagine each cue. They were advised to spend approximately ten seconds on each cue so that each card would take approximately a minute to complete. They were told not to move on to the next cue as soon as they get an image of the first one, but to spend some time on the details and vividness of each cue.

Each participant received a pack of either visual or auditory imagery stimuli cards. They were instructed to use one of these cards each time they experienced a craving for a cigarette, before they smoked the cigarette. They were told to take out a card and imagine either the image or sound of the stimuli on the card. They were asked to do the task in the order specified on the card, but they could use the cards themselves in any order and were told to dispose of each card after use.

The smokers in the visual imagery condition were told to imagine the appearance of something (e.g. a rose garden) as vividly as possible and to concentrate on getting the images and colours as clear and bright as possible, or imagine it as real as they can for around 10 seconds. The smokers in the auditory imagery condition were told to imagine the sound of the cue (e.g. a telephone ringing) as vividly as they possibly could; they were instructed to focus on the sound, and ignore any visual image that they might have along with it.

Participants were also told to keep a record of the number of cigarettes smoked during the day, at the end of each day in their smoking diaries. They were asked to do this for a period of six days, starting on the following day, and to come into the department with their smoking diaries, and the remaining cards after seven days.

Mid-week Phone Call: - The participants were called up mid-week to see how they were finding the imagery techniques, and to remind them of when they are coming into the department at the end of the treatment phase. In addition to reducing dropouts, this was intended to remind participants of the experimental requirements and to maximise compliance.

Post Treatment 1: - The participants returned to the department after a week of using the imagery techniques. Their carbon monoxide levels were recorded again and they handed in their smoking diaries and the remaining packs of cards. They were instructed to keep the smoking diaries for another six days and to come in for a final time after a week.

Mid-week Phone Call: The participants were rung up mid-week again to see how they were coping with the study, and to remind them of their final meeting in the department.

Post Treatment 2: - Final recordings of carbon monoxide levels were taken and the subjects handed in their smoking diaries. They were all debriefed about the two imagery techniques and how each imagery method was thought to affect craving. All the subjects received a pack of visual imagery cards with instructions on how to use them. The subjects in the auditory condition were also given a pack of auditory imagery cards if they felt it helped them control their cravings during the study. All subjects were also given a booklet called "Giving up for Life" from the NHS and £10 for their participation in the study.

9.2 Results

The smoking history, how long they had been a regular smoker, CO readings and scores of the FTND questionnaires of the participants who dropped out were compared to those who completed the study. There were no significant differences between the two groups in the average numbers of cigarettes smoked each day ($t(35) = 1.07$, ns), how long they had been a regular smoker ($t(35) = 0.46$, ns), the FTND scores ($t(35) = -0.027$, ns) or the CO readings ($t(35) = 1.75$, ns).

The average number of cigarettes smoked each week was recorded for each participant who completed the experiment. Carbon monoxide readings were also taken at the start of the experiment and then following each of the three experimental weeks. ANOVAs were conducted on the CO readings and average number of cigarettes smoked with *Imagery* condition (visual v auditory) as a between subjects variable and *Week* (baseline, treatment and post-treatment) as a within subjects variable.

The number of cigarettes smoked by the two groups over the three weeks can be seen in Figure 26. The number of cigarettes smoked showed a main effect of *Week* ($F(2,54) = 16.85$, $MSE = 3.12$, $p < 0.001$). The participants smoked less in week 2 of the study. However, there was no significant interaction between *Imagery* and *Week* ($F(2,54) = 0.85$, $MSE = 3.12$, ns) as both the visual and auditory conditions showed a reduction in the number of cigarettes smoked during the treatment week of the experiment. Both groups experienced a slight increase in the average number of cigarettes smoked in the final post-treatment week of the study (visual = 7.82; auditory = 7.45).

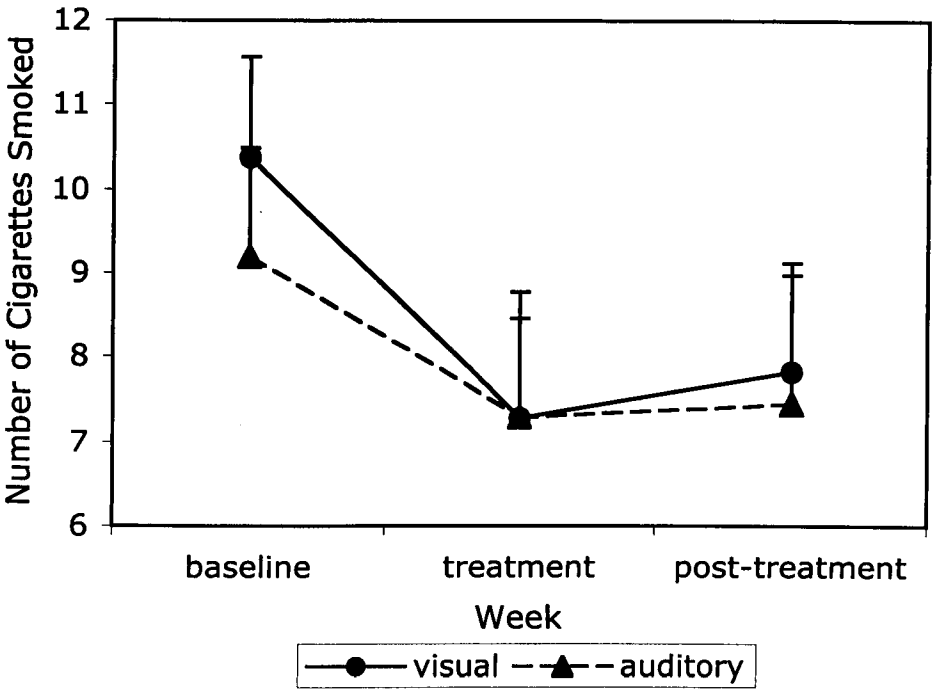

Figure 26: Number of cigarettes smoked during each week of the study with errors bars indicating +1 standard error.

Since a significant interaction was not observed between the two imagery conditions when looking at the average number of cigarettes smoked each week by the two groups, the average smoked each week was broken down to see if there were any patterns in the average numbers smoked each day across the three weeks. The average number of cigarettes smoked each day for each experimental week can be seen in Figure 27. Separate within subjects ANOVAs were carried on the number of cigarettes smoked each week with *Imagery* condition (visual v auditory) and *Time* (days 1 – 6) as factors. None of the analyses carried out for each week showed any main effects of *Imagery* condition. There was a significant interaction between the *Imagery* condition and *Time* in the baseline week ($F(5,135) = 2.47$, $p < 0.05$). The visual imagery group started the week off smoking more than the auditory imagery group; after the third day, however,

the amount smoked by the visual group decreased whilst a peak was observed in the amount of cigarettes smoked by the auditory group on Day 5. A similar peak on Day 5 is seen for the auditory group during the post-treatment week, again this would represent a Friday or Saturday night. The analysis carried out on the number of cigarettes smoked during the post-treatment week was approaching significance ($F(5,135) = 2.26$, $p = 0.052$). However, there was no significant effect of imagery on the amount smoked during the treatment ($F(5,135) = 0.47$, ns).

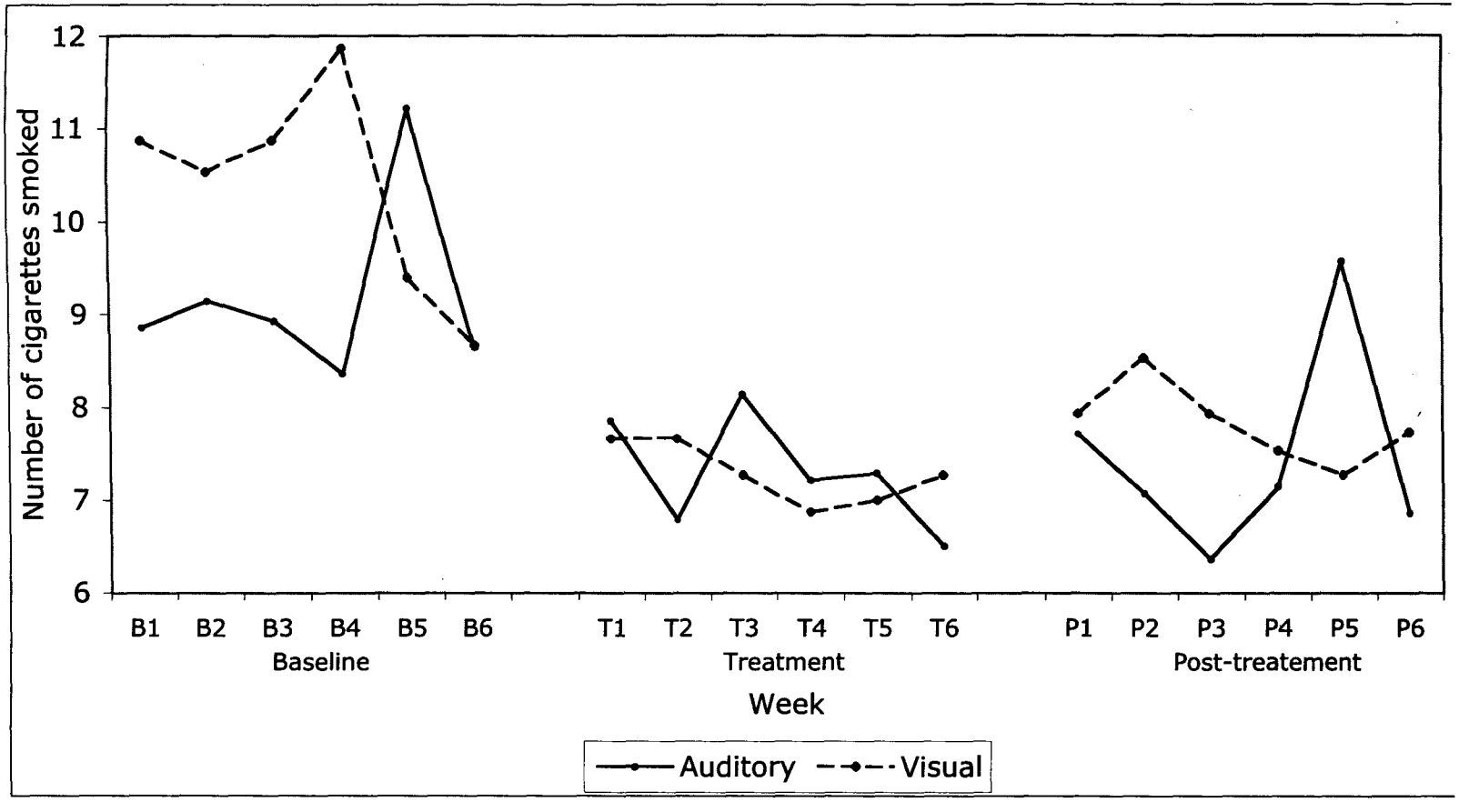

Figure 27: Average number of cigarettes smoked each day across the experimental weeks.

The drop in the total amount of cigarettes smoked during the treatment week for each participant was also calculated. These were then split into low (fewer than 3 cigarettes) and high (more than 3 cigarettes) drop groups. A chi-squared test was carried out to see if there were any contingencies in the data (Table 6). There was no significant difference between the groups ($p = 0.46$, Fishers Exact test).

	Auditory	Visual	Totals
Low	9	7	16
High	5	8	13
Totals	14	15	29

Table 6: Contingency table for total drop in amount smoked.

The initial carbon monoxide reading, taken on the participants' first visit into the department, was used as a baseline reading for their CO levels and compared to the readings taken between each experimental week of the study. The analysis carried out on the CO readings showed a significant interaction between *Imagery* condition and *Week* ($F(2,54)$ 3.82, $MSE = 10.21$, $p < 0.05$). There was also a significant difference between the imagery conditions at baseline. The variations of CO ratings during the study can be seen in Figure 28.

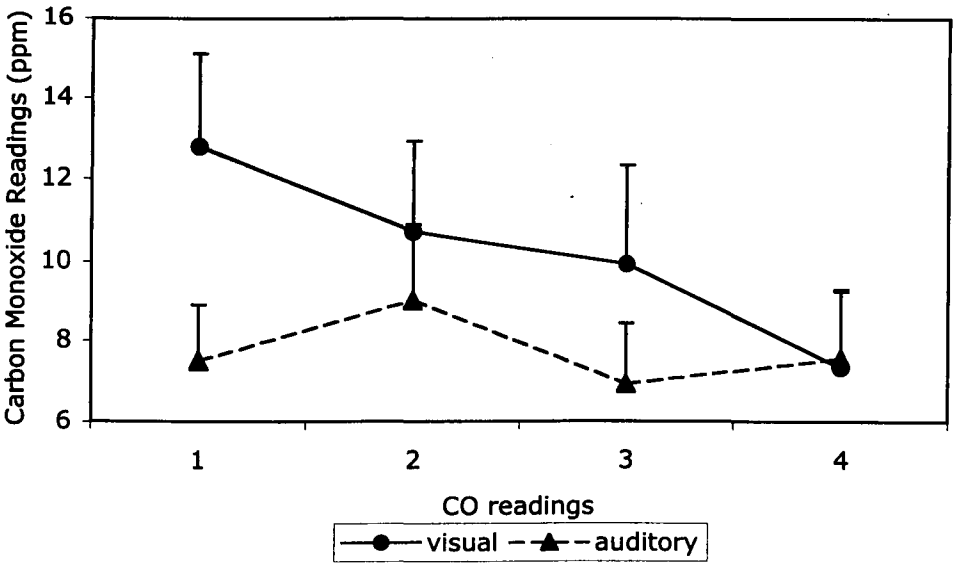

Figure 28: Changes in CO levels during study with errors bars indicating +1 standard error.

The levels of CO in the visual imagery group start off much higher than the auditory imagery group. The CO levels in the visual imagery group decrease from 12.80 at baseline to 9.93 after the treatment week and continue to decrease to 7.33 after the final week of the study. One way repeated measures ANOVA conducted on the CO reading showed that the visual imagery group ended the experiment with a significant lower reading ($F(3,42) = 6.21$, $MSE = 12.36$, $p < 0.05$) The CO levels of the auditory imagery group remain fairly constant across the three weeks of the study and did not show any significant differences ($F(3,39) = 1.37$, $MSE = 7.91$, ns).

The participants were asked to return their remaining cards after the treatment week so that the amount of cards used in the treatment week could be recorded. The amount of cards used by each participant was correlated with the drop in the number of cigarettes smoked. The sample numbers used here were quite small because some of the participants did not know how many cards they had used during the week. Participants who had used fewer than 10 cards during the treatment week were also excluded from this correlation. The scatter-plot in Figure 29 shows the relationship between doing the imagery task and the total drop in the number of cigarettes smoked during the study. The analysis did not show a clear relationship between the two variables (Visual group: $r = 0.38$, ns; Auditory group: $r = -0.08$, ns), despite a trend towards a relationship in the visual group.

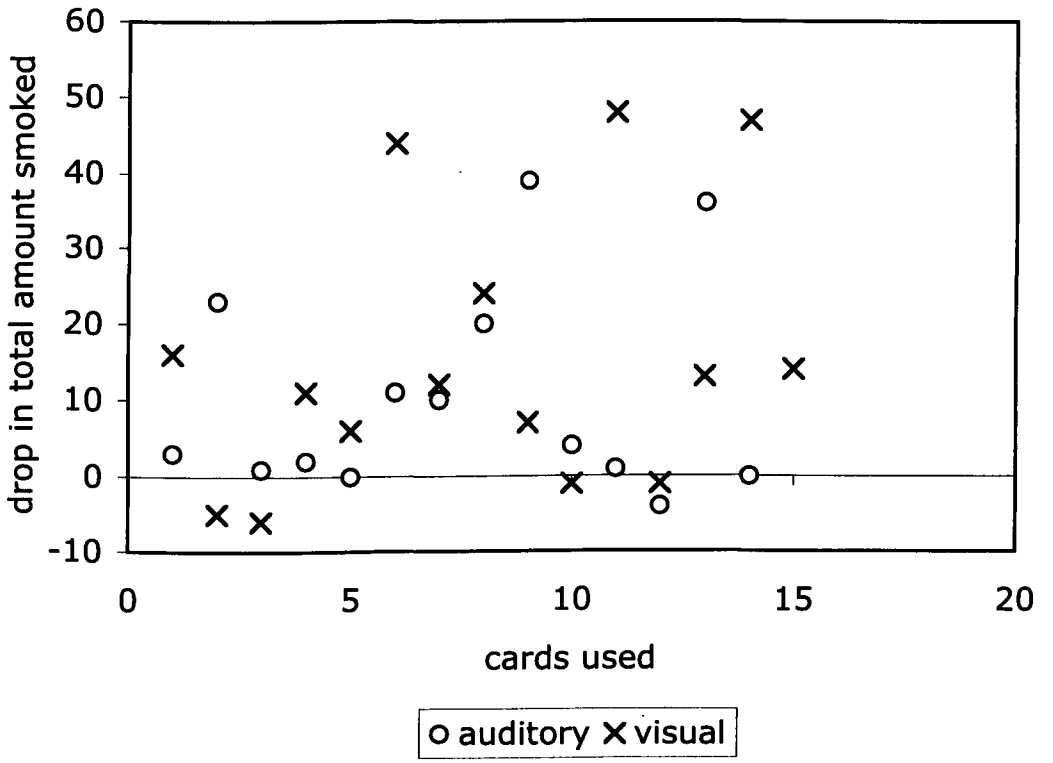

Figure 29: Graph showing relationship between number of cards used and reduction in smoking.

9.3 Discussion

The analysis comparing the dropouts to the people who completed the study was carried out to see if it was the heavy smokers who were unable to continue with the study. The results from the analysis showed that there were no significant differences in their smoking history or the amount they smoked between those who dropped out and those who completed the study.

A significant interaction was seen in the changes in carbon monoxide readings across the experimental weeks and the two imagery groups. The CO levels in visual imagery group decreased steadily throughout the experiment. The visual imagery group also started the study with significantly higher CO readings than the auditory imagery group. The reduction of CO levels are most likely to be owing to a reduction in the number of cigarettes smoked, brought about by the participants' desire to quit smoking, rather than the imagery tasks. This is supported by the fact that a greater decrease of CO levels is observed during the first monitoring week of the experiment. To ensure that the effects seen in the study were owing to the imagery condition and not the participants' desire to give up smoking, the study could have also included a condition where the smoking behaviour of the participants was monitored. The baseline-monitoring week might not be a sufficient control for the study.

Interpretation of the interaction is made problematic because, despite the matching of participants, there is a significant difference between the baseline CO readings of the two imagery groups and there is also quite a big difference between the smoking behaviour of the two groups in the baseline week of the study. The participants were matched according to their responses to the smoking history questionnaire using the average number of cigarettes they reported to smoke each day, and the nicotine content

of their cigarettes and then randomly allocated to one of the imagery conditions. However, this resulted in differences in smoking behaviour and CO levels between the groups. It might have been better to match the smokers according to their recorded CO levels and their smoking behaviour during the baseline week of the study.

The results from the study showed a decrease in the amount of cigarettes smoked by the participants of both the imagery conditions during the treatment and post-treatment weeks of the study. Decreases in smoking behaviour were expected in the visual imagery condition since Experiments 1 and 3 showed that visual imagery suppressed cravings in deprived smokers. The auditory imagery condition was not expected to have an effect on smoking. The changes observed in the auditory imagery condition may be due to the participants' general desire to quit.

The breakdown of the cigarettes smoked each day across the three weeks showed that smoking patterns differed over Day 5 and Day 6; there was a peak in smoking on Day 5 and a drop on Day 6, before the participants were due for their meeting in the department. For most participants (N = 18), this represented an increase in the participants' smoking over the weekend (Saturday and Sunday). Even though the visual imagery group appeared to consist of heavier smokers there was no overall difference in the average number of cigarettes smoked between the two groups. This was probably due to the peak in smoking on Day 5. On exclusion of Day 5 and Day 6 from the analysis, a significant interaction was observed between the two imagery conditions ($(F(2,54) = 3.34, MSE = 2,99, p < 0.05)$.

Figure 30 shows the smoking behaviour of the imagery group on exclusion of day 5 and Day 6. The auditory group appears to be experiencing a gradual drop in the number of cigarettes smoked during each week of the study. The visual imagery group, on the

other hand, experienced a greater drop during the treatment week. They also display an increase in the number of cigarettes smoked during the post-treatment week.

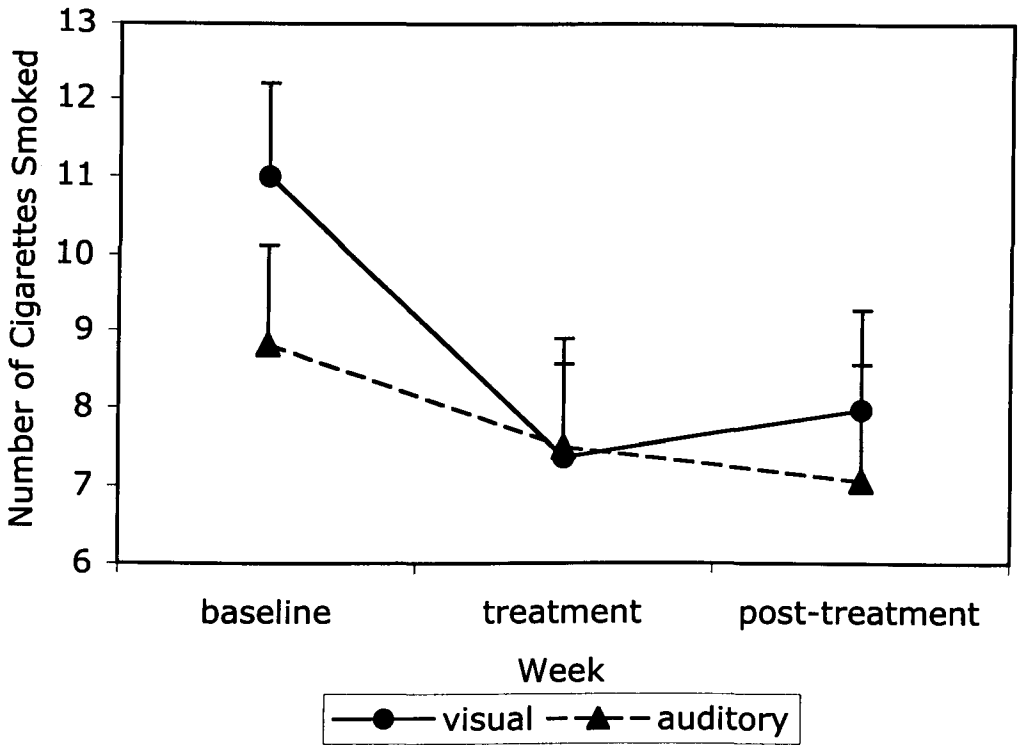

Figure 30: Number of cigarettes smoked during each week of study (excluding Day 5 and Day 6) with errors bars indicating +1 standard error.

Day 5 and Day 6 corresponded to Saturday and Sunday for 18 participants. If the different patterns of smoking during the weekend influenced the results then a similar effect should be seen if all the information collected on Saturday and Sunday were excluded from the analysis. Instead of removing Day 5 and Day 6 from each week for all the participants, Saturday and Sunday was excluded for each participant. The analysis was then repeated and resulted in an insignificant interaction between *Imagery* and *Week* ($F(2,54) = 0.88$, $MSE = 3.57$, $p>0.05$, ns). Therefore the effect cannot be due to different smoking patterns during the weekend. Instead, the peak in smoking is more

likely due to an increase in smoking on a Friday or Saturday night. The participants might be more likely to smoke if they were out in a social situation.

It is quite possible that the effect of visual imagery on craving is temporary. Even though the visual imagery task reduces the strength of craving, it might not be able to change the smoking behaviour and cause the smokers to smoke less. The smoking behaviour of participants might be influenced by other factors. However, due to the inconsistencies in the matching of participants as well as the differences in smoking patterns across the week, the study needs to be repeated before making any conclusions about the efficacy of the imagery tasks.

The overall decrease in smoking is seen in both groups. Since the participants were asked to complete the imagery task each time they had a craving, the reduction in the amount of cigarettes is possibly an effect of distraction; getting their mind off the craving itself. A lot of the comments from the smokers said that they felt the craving was being postponed and that they would have another craving soon after completing the tasks. Other comments from the participants were quite varied. Some felt the visual imagery task was really helping them in reducing their cravings whilst others felt the task was not helping them at all. Similar comments were made by the participants in the auditory imagery group. There did not appear to be a difference between the effects of the two tasks themselves. Some participants suggested that the items used on the imagery tasks could be changed into things that they were interested in. They felt that having the same 18 items repeated on 80 cards quickly got quite boring. Having a golfer imagine different golf courses or visualising shopping centres were some of the examples given.

The participants in the study were all motivated to quit smoking. This is a major difference between the earlier laboratory studies and the real-life intervention study. Intention has been identified as the most immediate and important cognitive antecedent of behaviour, and refers to an individual's decision to act and is also assumed to reflect the effort the person exerts in order to achieve the goal (Abraham and Sheeran, 2003). The strength of the individual's commitment to quitting smoking would be an indicator of how much effort that would go into trying to quit. Stronger intentions would be related to behavioural achievements (Ajzen, 1985). The participants took part in the study because they wanted to quit smoking. The motivation to quit, that the participants in this study had, may have masked the effects of the imagery tasks. However, it is important for a clinical intervention to have some benefit despite the motivation to quit. The motivation to quit is what would lead the individual to use the intervention technique, and it is important that the intervention has an effect.

The decrease in the amount of cigarettes smoked in both groups might have also been influenced by the Information pamphlets they received about giving up smoking. These would have acted as a brief intervention to help the smokers quit smoking. Since all the smokers received the pamphlets at the start of the study, this might have further masked the effects of the two imagery tasks.

Of the entire sample, three people managed to successfully give up smoking during the study. Two of these people were in the visual imagery group whilst one was in the auditory imagery group. These people said that their respective tasks helped them in controlling their cravings and that they would continue to use the tasks when they craved a cigarette. The different comments made by the participants in regard to the

imagery method they used during the study would suggest that individualised treatment might be more successful in helping people cope with their cravings.

The laboratory studies involved an urge induction imagery procedure to ensure that the participants were craving. This induced craving was effectively suppressed by the visual imagery task in Experiment 1 and 3. However, the expected effect of the visual imagery task was not observed in the intervention study. It is conceivable that, although the urge induction was intended to be multi-sensory, it induced artificially high levels of craving-related visual imagery. It may have been this "unnatural" craving that visual imagery disrupted. Experiment 3 has recently been replicated as an undergraduate project, using a non-imaginal urge induction procedure ("you can smoke as soon as you finish the experiment"), to see if the effects are observed in more naturalistic craving. Unfortunately, recruitment of smokers for the study was difficult and most of the smokers used in the study were low use smokers and smoked less than 10 cigarettes a day, unlike the smokers used in the laboratory experiments reported here. Overall, there was no effect of imagery and visual noise manipulations on craving. However, on exclusion of smokers who smoked less than 10 cigarettes a day, then there was a significant decrease in craving strength in the visual imagery+ SVN condition and a non-significant effect in the auditory imagery + DVN condition, but the numbers in each group were small. The results suggest that visual imagery decreases craving even without the imaginal urge induction procedure but more smokers need to be tested before any strong conclusions can be drawn about the use of the urge induction procedure.

The results from Experiments 1 and 3 showed that the visual imagery task and DVN were able to reduce craving ratings in deprived smokers. These tasks could potentially

be developed into a treatment intervention. This study investigated the use of the task as an intervention in a real-life setting. There was a difference between the results obtained in the laboratory and the results observed in this study. No clear effect of visual imagery on smoking was observed. Though imagery reduces the strength of craving experienced by the smokers, it might not have an effect on smoking behaviour. Better matching of the participants at baseline and avoiding repetition of the items on the imagery cards may have shown a clearer effect of imagery on smoking behaviour. Further research using the tasks outside the laboratory and refining this study would be necessary to see if any effects can be observed when using the imagery techniques as an intervention technique.

10 Discussion

The present research was carried out to test key predictions made by the Elaborated-Intrusion theory of desire. The theory is a new cognitive account of craving, which acknowledges the emotional and motivational aspects of craving. It suggests that craving is associated with two types of cognition: Intrusive and Elaborated thoughts. According to the EI theory, both appear to trigger appetitive behaviour but do so in different ways. Intrusive thoughts are experienced as spontaneous or sudden and the triggers that cause them are unavailable to the individual because they occur below awareness. The individual is aware of a substance related thought but unaware of what caused it. These thoughts are believed to occur usually when focused on another task whilst elaborated thoughts involve more consciously directed mental activity. The research also focuses on the generality of craving and looks at the occurrence of everyday craving for non-addictive substances as well. Theories about craving usually concentrate on addictive substances like drugs and alcohol. However, the EI theory looks at the similarities between drug craving and desires for things like food, warmth and sex. Craving is seen as an everyday aspect in human motivated behaviour. The main focus of this research is on the EI theory's central claim about the importance of mental imagery in craving. The theory proposes that the cognitive elaboration processes involve the search, retention and manipulation of craving related information in working memory, and this information is combined to form sensory images of the target or target-related situations. The craving is maintained in awareness as these elaborated thoughts contribute to cycles of rewards and further elaboration.

The thesis consists of a series of studies, which first attempts to explore the phenomenon of craving in the natural environment and in particular, the importance of imagery. It then goes on to test, experimentally, the EI theory's central claim that target-

related imagery is a key feature of desire. The research reported here consists of a set of experiments that use concurrent tasks to explore the effects of competing visual imagery on cigarette craving. The results of the experiments are discussed below.

10.1 Summary of Results

Questionnaire Studies

Many of the existing questionnaires are aimed at measuring cravings for addictive substances (Tiffany and Drobes, 1991; Tiffany et al., 1993; Bohn et al., 1995). The first questionnaire study reported here was used as a preliminary assessment of everyday cravings in a non-clinical sample. The present research focuses on the generality of craving and investigates descriptions of craving for addictive substances such as tobacco, as well as more general craving for food and drink (e.g. chocolate, coffee). The results from this study showed that the triggers and descriptions of craving episodes were consistent with the EI theory's claims about intrusive and elaborated thoughts. The respondents did not appear to be aware of what was causing their craving; the statement "I suddenly thought about it" received high ratings by the respondents. Once they begin to crave, the results suggest that they experience visual and olfactory images of their desired substance.

The second questionnaire study compared responses to tobacco cravings with general cravings for food and drinks that smokers' experience. The study also compared the everyday cravings for non-addictive substances in smokers and non-smokers and looked at whether responses from cravings for addictive substances provided support for the existence of an addictive personality type. It looked at whether being addicted to one substance, like tobacco, makes the individual's craving experience different to that of someone who does not crave addictive substances. The incentive-sensitization theory

(Robinson and Berridge, 1993) discusses individual differences in susceptibility to sensitization. They suggest that some individuals are more prone to becoming addicts, which would explain why some drug users become addicted while others are more resistant. They also suggest that once dopaminergic pathways are sensitised to one type of drug, the individual is increasingly prone towards experiencing extreme desires for other substances as well. The second questionnaire was designed to explore the differences between tobacco addicts and people who had general food or drink cravings to see if there was support for addictive personalities. The results obtained in the analysis of general food and drink cravings replicated the results observed in the first questionnaire and showed no consistent difference between tobacco and other cravings, or between general (non-tobacco) cravings of smokers and non-smokers.

The results observed in the second questionnaire raised some doubts about the accuracy of retrospective questionnaires used in other studies. Further research using the questionnaires should more systematically compare responses made at the time of craving and responses made whilst not actively craving.

Visual Imagery Studies

The predictions made by the EI theory about the generality of craving and the distinction between intrusive and elaborated thoughts are supported by the results observed in the questionnaire studies. The respondents' described their cravings as being intrusive and spontaneous; they did not seem aware of what was causing their craving. Their descriptions of the cravings appeared to suggest that visual imagery was involved in the experience; "I am visualising it" was highly rated by cravers of many substances, including tobacco.

The subsequent experiments explored the central claim of the theory about visual imagery being a crucial part of the experience of craving. The studies used a working memory approach to investigate the cognitive processes underlying the craving experience. Experiments 1-3 tested whether craving involved visual imagery by testing whether craving strength could be reduced by a concurrent task that selectively loaded onto the cognitive processes involved in the generation and maintenance of images of the desired substances. These studies explored the effects that active and passive tasks, known to interfere with visual imagery, had on cigarette cravings in deprived and non-deprived smokers.

The final experiment in the thesis explored the use of a visual imagery task as a possible intervention technique for people trying to give up smoking. Experiments 1 and 3, but not experiment 2, showed that blocking imagery with tasks that loaded onto the visuo-spatial sketchpad of working memory reduced craving in deprived smokers. Experiment 4 investigated whether the visual imagery task could be used to change smoking behaviour outside the laboratory setting. The inability to control their cravings is often the reason given by smokers when asked why they relapsed after successfully abstaining for many years. Cravings are also very difficult to manage when trying to quit (Pickens and Johanson, 1993; Tiffany, 1990). Based on the results from the previous experiments, it was predicted that the visual imagery task would help in the quitting process by reducing cravings experienced by the participants when trying to give up smoking; the auditory imagery task was not expected to have an effect on craving ratings.

The results observed did not show a difference between the two tasks, and both groups were smoking less during and after treatment. There were no significant differences

between the effects of the two tasks on the amount of cigarettes smoked during the study. The motivation to quit smoking as well as the intervention procedures might have masked the effects of the imagery tasks. The participants should have been matched better when they were allocated into their imagery groups. This would have helped to draw a firm conclusion about the effectiveness of the tasks.

To summarise, the two questionnaire studies explored individuals' subjective craving experiences and the three experimental laboratory studies investigated the EI theory's prediction that visual imagery is a central concept of craving. The results generally supported this claim and showed that interfering with visual imagery provides a method of suppressing craving. This has important implications for the treatment and management of craving episodes as it could provide a simple yet effective way of controlling an individual's cravings. Though the final experiment in this thesis did not have the expected result on smoking behaviour, refining the study may provide a different pattern of results. More research also needs to be carried out to test whether same effects observed in Experiments 1 – 3 can be observed when relying exclusively on smoking deprivation to create craving rather than using the urge induction procedures.

10.2 Evaluation of Results

The results from the questionnaire studies showed that cravers do not tend to attribute their craving to any internal or external cues. Craving was reported as being sudden and spontaneous. Even though the trigger could be due to something in the environment or mood, the individual cannot attribute a cause to the craving because the cue occurs below conscious awareness. According to the EI theory, external cues, cognitive associations, negative moods or physiological deficits could trigger the craving.

However, the craving related thought is experienced as spontaneous because the actual trigger is not available to conscious inspection.

The idea of unconscious desire thoughts is also addressed by Robinson and Berridge (2000) in their theory of incentive-sensitization. They suggest that the neural system responsible for incentive attribution can produce goal-directed behaviour, which is produced in the absence of conscious awareness of "wanting" itself. Robinson and Berridge suggest that this process is thought to constitute an implicit psychological process and can act as an unconscious motivational process. They explain that it is because of these unconscious psychological processes that addicts have little insight into why they want the drug. This concept of unconscious wanting is similar to the antecedents of intrusive thoughts proposed by the EI theory.

Once the craving is in awareness it dominates the individual's thoughts until the craving episode is terminated, either by acquisition of the desired substance or by other cognitive demands (Kavanagh et al., under review). The EI theory's focus on the conscious cognitive components of craving differs from account provided by Robinson and Berridge. Since the cravers are unable to identify the cues or triggers to their craving, it makes it difficult to suggest management techniques that focus on avoiding having the craving altogether. Controlling for potential triggers is not impossible, as avoiding situations full of conditioned cues or occupying oneself with alternative pleasurable activities can help avoid intense craving episodes. Thought suppression, however, is at best ineffective (Salkovskis and Reynolds, 1994, Palfai et al., 1997). Trying to control appetitive thoughts and behaviour might lead to obsessional thinking as trying to avoid having thoughts about a desired substance only works to increase their intrusive nature (Wegner, 1994). A more effective way of controlling craving

might involve attempting to manage the craving episode after it occurs, rather than trying to avoid thinking about the craved substance at all.

Most studies on craving are based on addictive substances like drugs and alcohol. The EI theory attempts to explain the links between cognitive and affective factors in desire. Kavanagh et al. (under review) argue for a general set of cognitive-motivational processes, which go beyond the confines of drugs and can be applied to food, drink, warmth or sex. Craving-related thoughts affect performance on a wide range of cognitive tasks. Though everyday craving for food and drink may be slight in comparison to cravings for cocaine or cigarettes, a complete account of craving should be applicable to non-addictive substances as well. The results from the questionnaire studies do not show any differences in craving strength or quality between everyday craving and craving for addictive substances like tobacco and support the generality of the craving experience. This suggests that craving for addictive and everyday substances are in fact similar in experience and are controlled by a common mechanism.

The research reported here, along with the EI theory's predictions, is not only beneficial in the development of treatment but would also be useful with the problems associated with definitions and measurement. The results observed in the questionnaire studies also provide insight into the problems of measurement. Most of the existing questionnaires (e.g Bohn et al., 1995; Shiffman and Jarvik, 1985) on craving rely on retrospective responses. However, these responses may be biased by stereotypical views of craving. The results from questionnaire studies carried out in this research suggested that the time of responses influenced the pattern of responses observed. Providing responses at the time of craving would be a more accurate representation of the experience than responses that are based on what the individual thinks the craving ought to be like.

Problems with reliable accurate measurement of craving only add to the problems with understanding the concept of craving. When considering triggers for craving, for example, the questionnaire showed that respondents were not aware of the cause of their craving; the trigger occurs below awareness. As mentioned earlier, recall of past experience would be influenced by the respondent's current state, intervening experiences and the salience of experience. Respondents may be more likely to attribute a cause to their craving when thinking back on their experience, even though they might have been unaware of what actually brought on the craving during the episode itself. This would not be an accurate representation of how they were feeling at the time of craving, as it would lead to either an overestimation or underestimation of their past craving experiences.

10.3 The Role of Imagery in Craving

Even though previous studies have used imagery techniques to induce craving in the laboratory (Tiffany and Hakenewerth, 1991) researchers have not explained the relationship between imagery and craving. Imagery has been suggested to be a part of the craving experience (Salkovskis and Reynolds, 1994) but there have not been any systematic studies that explore the association between craving and imagery. The EI theory introduces the idea that imagery might be a crucial aspect of the craving experience and the research reported in this thesis attempts to provide empirical evidence for this association.

Earlier research in craving focused on its interference with other cognitive tasks and thoughts about desired substances have been shown to affect performance on concurrent cognitive tasks. The effort involved in obtaining the desired substance, or abstaining from it, involves controlled conscious cognitive processing. Attention is drawn to the

craving itself and away from the concurrent task the individual might be trying to complete. The craving engages considerable cognitive resources and therefore impairs performance on other activities and causes disruptions in the individual's everyday activities (Channon and Hayward, 1990; Lavy and van-den-Hout, 1993; Gross et al., 1993; Sayette and Hufford, 1994; Cepido-Benito and Tiffany, 1996).

The EI theory proposes that it is the elaborative thought processes and, specifically, the use of working memory resources to support imagery that cause this interference. Appetitive thoughts are expected to affect the performance on a wide range of concurrent tasks and the strongest interference would be expected with tasks that compete for the limited-capacity processes of working memory. Since the elaborative thoughts are believed to involve visual imagery and concurrent tasks are known to interfere with emotive imagery (Baddeley and Andrade, 2000), this thesis uses concurrent cognitive tasks to reduce craving by interfering with cravers' thought processes. To test the EI theory's prediction, concurrent tasks, which load onto the same cognitive processes involved in the generation and maintenance of images of the desired substance, are used to investigate the underlying cognitive processes of craving. Although inconsistent results were observed in Experiment 2, Experiments 1 and 3 showed that the visual imagery task and the DVN task brought about a reduction in craving ratings in deprived smokers. Since these tasks are known to occupy the visuo-spatial sketchpad of working memory and interfere with visual imagery tasks, it can be assumed that the observed reduction in craving was caused by the blocking of craving-related visual imagery. These findings support the EI theory's claim that visual imagery is a key aspect of the craving experience.

The results observed in this thesis have been replicated with food cravings. The experimental design used in Experiment 1 was adapted to explore the imagery processes underlying food cravings (Harvey et al., in press). They found that the craving ratings were reduced more significantly following the visual task than the auditory task. Similar results were seen in another study on food cravings. Kemps, Tiggemann, Woods and Soekov (2004) looked at the effectiveness of different visuo-spatial tasks - DVN, saccadic eye movements and spatial tapping - in reducing food cravings in dieters and non-dieters. Their results showed that concurrent visuo-spatial activity reduced the intensity of food cravings in both dieters and non-dieters.

The fact that the visual imagery basis of cigarette cravings also extends to food cravings provides further support for the cognitive mechanisms underlying craving and shows that food and cigarette cravings can be reduced in similar ways. The research reported here and research carried out by Harvey et al. (in press) and Kemps et al. (2004) suggest that concurrent visuo-spatial processing is able to reduce both cigarette and food cravings owing to cognitive interference in the visuo-spatial sketchpad of working memory. Auditory imagery is shown to have no effect on craving. However, to ensure that the reduction in craving is not just a representation of the natural history of craving and simply caused by the passage of time, or that the interference is caused by interference in the visuo-spatial sketchpad and not by an overall central executive interference, the effects of a non-imagery task on craving should also be explored. The cognitive load from the visual imagery task must also be compared to that of the auditory imagery task, to make sure the visual imagery task is not just harder to complete than the auditory task. Including a task such as articulatory suppression task (repeating the...the...the) and looking at its effects on craving might prove that the interference with craving is restricted to concurrent tasks that load onto the visuo-spatial

sketchpad of working memory. Visuo-spatial tasks may be used to provide useful techniques for the treatment in food and cigarette cravings in both clinical and non-clinical populations.

The results observed here provide support for the EI theory of desire. The role of imagery in craving is not explained by any of the existing theories of craving. Though imaginal induction has been used for cigarette (Tiffany and Hakenewerth, 1991) and food (Green et al., 2000) cravings, an explanation as to why the method is successful is not provided. Some of the present theories of craving are based on the neurophysiological basis of craving; they discuss the brain regions or pathways involved in craving. Other theories explore the conditioned cues that cause craving. The mental processes that are active during the craving episodes have not been fully explained by conditioning or neurophysiological theories. The EI theory's argument is not that craving operates without a biochemical substrate or that knowledge about brain functioning is not important in the study of craving. It incorporates aspects of both conditioning and neurophysiological theories, but suggests that a cognitive level of explanation is necessary to account for the cognitively complex phenomenon of desire which captures the subjective experience of craving, and explains its relationship to general motivational and emotional systems.

Some of the existing craving models also focus on conditioned cue reactivity, the underlying physiological processes involved in addiction, or the cognitive processes involved in either obtaining or avoiding the desired substance. Some models regard craving as an epiphenomenon (Robinson and Berridge, 1993; Tiffany, 1990), and describe craving as a cognitive rationalisation used by addicts to explain relapse, but one which is neither necessary nor sufficient to cause relapse. Models that do attribute a

causal role to craving suggest that it is moderated by other variables (Niaura et al., 1988). The EI theory sees craving as the experience of a particular cognitive activity rather than an epiphenomenon. Craving is described as the state associated with the cognitive activity involved which includes the emotional and motivational aspects of the experience as well.

The EI theory of desire provides a more complete account by explaining how physiological responses to substance withdrawal are modulated by cognitive and emotional factors. Exploring the mental processes involved in a craving episode would help explain why cravings can be resisted by some people, who are able to abstain successfully and why others are unable to resist their cravings. It would also explain how craving can occur in the absence of withdrawal and how craving interacts with conditioned responses to substance-related cues (Kavanagh et al., under review). The EI theory attempts to provide an integrative model of craving which spans a range of appetitive behaviours and accounts for the full body of related evidence.

Learning more about the types of cognition involved in craving can help in determining the individual's experience of craving as well as predicting ways in which the craving would disrupt concurrent cognitive activity. This would also help in suggesting possible treatment mechanisms. At least with smokers, their smoking behaviour appears to be very personalised, different people have different smoking habits and patterns. To be effective, treatment should be individualised to match the differences, such as differences in the modality of imagery driving craving. Further examination of the EI theory might result in the identification of individual differences, such as differences in the modality of imagery driving the craving, and treatment should be tailored to suit these differences to be successful.

10.4 Future Research

The studies discussed here could be refined to produce further tests of the theory. The questionnaires were designed to get "at-the-time" responses from craving. These would be a more accurate representation of the craving experience compared to retrospective responses, which might be biased according to their stereotypes of craving. The difference in responses between retrospective responses and at-the-time responses should be explored further to help interpret previous research that used retrospective measures. The results obtained from the questionnaire studies showed a difference in the pattern of responses based on time of completion. Though retrospective responses are used reliably in clinical research, a more accurate representation of craving episodes maybe observed with questionnaires that are completed at the time of craving. The EI theory suggests that people have little insight on the actual cause of their craving. Relying on retrospective descriptions of craving might not represent an accurate description of an individual's craving episodes and may not be useful when trying to develop successful methods of managing craving. A study could be carried out comparing the responses to questionnaires that are filled out the moment they get them (the respondents would not be actively craving when they complete the questionnaire), with responses made when they are actively craving.

Further research should investigate the development of visual imagery as an intervention technique more thoroughly. Cognitive behaviour therapy (CBT) is known to be effective in the treatment of addiction and involves self-monitoring of behaviour, examining the functional relationship between environmental cues and appetitive behaviour and training in a range of relevant control skills (Mattick and Jarvis, 1994). Present methods aimed at reducing desires involve cue exposure techniques similar to those used for anxiety disorders. Patients are exposed to the desired substance whilst

resisting consumption, which eventually leads to habituation and a reduction in pre-consummatory behaviour. Combining CBT with pharmacological methods has been shown to improve outcome. The maintained effectiveness of drugs such as Naltrexone, once the medication has been stopped, appears to be mainly owing to facility of behavioural control (O'Malley et al., 1996). The literature on the outcome of these methods is fairly mixed and further investigation of the EI theory might suggest ways in which cognitive treatment mechanisms may be improved. The EI theory and this research can be developed to help people control their substance use. Teaching them methods of controlling craving and demonstrating that these control skills are sufficient may greatly improve outcome.

The main focus of this research has been elaborated thoughts and the imagery aspect of craving. But the EI theory's dual process view of craving suggests that two different types of cognitive phenomenon should be demonstrable. The distinction between intrusive and elaborated thoughts emphasises the importance of underlying processes of craving and the understanding of the initiation and impact of desire. The EI theory predicts that monitoring suppression of intrusive thoughts would lead to an increase in their availability and salience similar to Wegner's ironic thoughts. To fully explore the EI theory, research must also be carried out on the intrusive thought processes to see if distracting tasks can be used to reduce the salience and occurrence of these thoughts.

Since the studies show that interfering with visual imagery brings about a suppression of craving for cigarettes, then support for the idea that visual imagery could be used to affect smoking behaviour would provide simple yet potentially powerful treatment mechanisms. The final experiment in this thesis should be developed further to explore the effects of the visual imagery task outside the laboratory settings. The findings from

Experiments 1 and 3 suggest that visual imagery tasks could be used to provide relief for smokers during abstinence and could be used to develop methods of managing craving episodes. The visual imagery method might not be able to make people give up their addiction but it could be useful in helping people who are trying to abstain. Since preventing cravings from occurring is difficult, methods of reducing the craving might be more effective in managing them. However, Experiment 4 did not show the expected effects of the visual imagery task on the smoking behaviour of the participants. Refining the study may provide a different pattern of results. The visual imagery task could be further developed to provide a reliable method of helping people control their cravings. An individualised management technique that uses visual imagery may be successful in treating addicts. The comments made by the participants from Experiment 4 suggest that using a more personalised approach in the visual stimuli used in the task may result in more successful outcomes. The repeated use of the same 18 cues in the tasks was reported to be boring and adapting the cues used in the task to maintain the interest of the participants may be more successful. An appropriately designed task could be used to interfere with craving and help the individual manage an episode. Further research into the theory and the tasks that interfere with craving imagery may result in development of successful methods of relapse prevention.

Most of the research in this thesis is based on smokers and their cravings. The application of these methods to other addictions is necessary to see if similar effects would be observed when using other addictive disorders. Different appetitive targets or activities may involve different sensory modalities and different forms of imagery. Craving for alcohol might be reduced by visual imagery tasks. Gamblers may be particularly interesting because the desire to gamble might involve auditory elaboration; slot machine noises or even radio calls in horse races. Reductions in craving in this case

may be caused by an auditory imagery task rather than visual imagery as in smoking. One of the important features of the EI theory itself is that it is not just applicable to addictive substances but that the theory can be applied to desires for food, warmth or sex.

10.5 Conclusion

Cravings are a common and intense experience, and have great emotional and motivational significance to an individual. They are considered important in the study of addiction, as they are known to contribute to the maintenance of substance abuse and bring about relapse in those who are trying to abstain. This thesis investigates a new theory of craving. The EI theory is a cognitive-emotional model of craving that can be used to explain the elicitation and maintenance of desire. The present research was carried out to test key predictions made by the theory. It takes craving beyond the confines of drug craving and investigates the phenomenology of everyday craving in naturalistic settings. The experiments then focus on the EI theory's hypothesis that visual imagery is a central feature of the craving experience and use a working memory approach to examine the underlying processes of craving. The results show that concurrent cognitive tasks such as visual imagery and, equivocally, DVN are able to suppress cravings in deprived smokers. Tasks that block substance related mental imagery might be useful in developing treatment techniques for people who are trying to abstain. The visual imagery methods reported here might not be effective in making people give up their addictions, but they could be used to develop methods to help in controlling craving episodes. Combating craving is important in helping people recover from their dependence and should help in the overall quitting process.

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Appendices

APPENDIX A

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What is craving?

Everyone knows what craving is – it is an intense desire for something like food, or tobacco, or a drink of some kind, which at one time or another we have all experienced. Despite this, the causes of craving and the ways it influences our behaviour are not well understood. You can help us to discover more about craving by completing this brief questionnaire and returning it to us in the envelope provided. All replies are entirely anonymous, and we have no way of identifying the people who have returned the questionnaires. We hope that the results of this survey will help us to improve the support for people who are trying to cut down on some substance.

Please keep this questionnaire nearby until you find that you are craving something, and then fill it out as accurately as you can.

CRAVING QUESTIONNAIRE. Please fill this side in first.

Today's date (dd/mm/yy) [/ /] Time now (hh:mm) [: am/pm]

Your Date of Birth (dd/mm/yy) [/ /] Sex : M ☐ F ☐

1. What are you craving? Please circle the appropriate category and specify substance.

Food Alcoholic drink Non-alcoholic drink Tobacco

Specify substance: [ ]

2. How strong is this craving right now? (please circle the appropriate number)

Very *1 2 3 4 5 6 7 8 9 10* Overwhelming
Slight

3. What *triggered* this craving?
Please circle one number in each row

	Not at all				Definitely
Other things I was thinking about reminded me of it.	1	2	3	4	5
I felt stressed / anxious / sad	1	2	3	4	5
I pictured myself having it	1	2	3	4	5
I suddenly thought about it	1	2	3	4	5
I felt happy	1	2	3	4	5
I saw / heard / smelled it	1	2	3	4	5
I had nothing else to do / I was bored.	1	2	3	4	5
I always have it at that time/place.	1	2	3	4	5
I imagined the smell / taste of it	1	2	3	4	5
I felt hungry/thirsty/ tired / physical discomfort	1	2	3	4	5
I was really busy	1	2	3	4	5
I imagined the sound of myself having it	1	2	3	4	5

(Now Please Turn Over)

Please complete the OTHER side first

4. Please rate the following statements as descriptions of this particular craving. Please circle a number in each row.

	Not at all				Definitely
I wanted it because I am hungry / thirsty / tired / in physical discomfort	1	2	3	4	5
I have it with me right now.	1	2	3	4	5
I am imagining the taste of it	1	2	3	4	5
I am visualising it	1	2	3	4	5
I am thinking of how much better I will feel after I have had it	1	2	3	4	5
I am trying to resist having it	1	2	3	4	5
I can hear myself having it	1	2	3	4	5
Having it would feel very comforting right now.	1	2	3	4	5
If I don't think about it, my craving will go away.	1	2	3	4	5
I would feel more relaxed if I had it.	1	2	3	4	5

If none of the above statements apply to your craving, please state what you think best describes this craving:

_____

_____

6. Have you given in to your craving? Yes ☐ No ☐

If No, will you give in? Yes ☐ No ☐

7. Are you currently trying to cut down on it? Yes ☐ No ☐

Thank you very much for your help.
Please return the questionnaire in the envelope provided.

Yours sincerely,

Nathalie Panabokke,
Department of Psychology, University of Sheffield.

APPENDIX B.

THE UNIVERSITY OF SHEFFIELD

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Craving Questionnaire

A craving is an intense desire for something like food, or tobacco, or a drink of some kind, which at one time or another we have all experienced. Despite this, the causes of craving and the ways it influences our behaviour are not well understood. You can help us to discover more about craving by completing this brief questionnaires and returning it to us in the envelope provided. All replies are entirely anonymous, and we have no way of identifying the people who have returned the questionnaires. We hope that the results of this survey will help us to improve the support for people who are trying to cut down on some substance.

Your Date of Birth (dd/mm/yy) [/ /] Sex : M ☐ F ☐

Please keep this questionnaire nearby until you find that you are craving food, drink, or tobacco. If you use any tobacco product, please fill out both sides before returning to us. If you do not use tobacco, just fill out this side.

Please complete this side for a craving for food or drink.

What are you craving? [ ]

Today's date (dd/mm/yy) [/ /] Time now (hh:mm) [: am/pm]

How strong is this craving right now? (please circle the appropriate number)

Very Slight *1 2 3 4 5 6 7 8 9 10* Overwhelming

How well do these statements describe your craving?
Please circle a number in each row.

	Not at all				Definitely
I am trying to resist having it.	1	2	3	4	5
I feel stressed / anxious / sad	1	2	3	4	5
I am picturing myself having it	1	2	3	4	5
I suddenly thought about it	1	2	3	4	5
Having it would feel very comforting	1	2	3	4	5
I would feel more relaxed if I had it	1	2	3	4	5
I have nothing else to do / I am bored	1	2	3	4	5
I am imagining the smell/taste of it	1	2	3	4	5
I want it because I am tired/uncomfortable	1	2	3	4	5
It is easily available right now	1	2	3	4	5
I always have it at this time/place	1	2	3	4	5
I saw / heard / smelt it	1	2	3	4	5
My body needs it	1	2	3	4	5
I am not able to have it right now	1	2	3	4	5

Thank you. If you do not use tobacco in any form, tick this box ☐ and return the form to us in the envelope provided, or to the address at the top of the page. If you do use tobacco, compete the other side too.

Please complete this side for a craving for tobacco.

Today's date (dd/mm/yy) / / Time now (hh:mm) : am/pm

How strong is this craving right now? (please circle the appropriate number)

Very Slight *1 2 3 4 5 6 7 8 9 10* Overwhelming

How well do these statements describe your craving?
Please circle a number in each row.

	Not at all				Definitely
I am trying to resist having it.	1	2	3	4	5
I feel stressed / anxious / sad	1	2	3	4	5
I am picturing myself having it	1	2	3	4	5
I suddenly thought about it	1	2	3	4	5
Having it would feel very comforting	1	2	3	4	5
I would feel more relaxed if I had it	1	2	3	4	5
I have nothing else to do / I am bored	1	2	3	4	5
I am imagining the smell/taste of it	1	2	3	4	5
I want it because I am tired/uncomfortable	1	2	3	4	5
It is easily available right now	1	2	3	4	5
I always have it at this time/place	1	2	3	4	5
I saw / heard / smelt it	1	2	3	4	5
My body needs it	1	2	3	4	5
I am not able to have it right now	1	2	3	4	5

Have you given in to your craving? Yes ☐ No ☐

If No, will you give in? Yes ☐ No ☐

Are you currently trying to cut down on tobacco? Yes ☐ No ☐

Thank you very much for your help.
When you have completed both sides, please return the questionnaire in the envelope provided.

Yours sincerely,

Nathalie Panabokke,
Department of Psychology, University of Sheffield.

Appendix C: Questionnaire of Smoking Urges (QSU Brief)

S:_____

D:___/___/___

Please state the degree to which you are currently experiencing the following states of mood by circling the appropriate numbers:

I crave a cigarette right now

Strongly disagree 1___2___3___4___5___6___7 *Strongly agree*

Even if it were possible, I probably wouldn't smoke now

Strongly disagree 1___2___3___4___5___6___7 *Strongly agree*

I am not missing smoking right now

Strongly disagree 1___2___3___4___5___6___7 *Strongly agree*

I would enjoy a cigarette right now

Strongly disagree 1___2___3___4___5___6___7 *Strongly agree*

If I had a lit cigarette in my hand I probably wouldn't smoke it

Strongly disagree 1___2___3___4___5___6___7 *Strongly agree*

Right now I am making plans to smoke

Strongly disagree 1___2___3___4___5___6___7 *Strongly agree*

I have no desire for a cigarette right now

Strongly disagree 1___2___3___4___5___6___7 *Strongly agree*

A cigarette would not taste good right now

Strongly disagree 1___2___3___4___5___6___7 *Strongly agree*

I will smoke as soon as I get the chance

Strongly disagree 1___2___3___4___5___6___7 *Strongly agree*

A cigarette would be very satisfying right now

Strongly disagree 1___2___3___4___5___6___7 *Strongly agree*

If I were offered a cigarette, I would smoke it immediately

Strongly disagree 1___2___3___4___5___6___7 *Strongly agree*

I have an urge for a cigarette

Strongly disagree 1___2___3___4___5___6___7 *Strongly agree*

I don't want to smoke right now

Strongly disagree 1___2___3___4___5___6___7 *Strongly agree*

Smoking a cigarette would not be pleasant

Strongly disagree 1___2___3___4___5___6___7 *Strongly agree*

I am going to smoke as soon as possible

Strongly disagree 1___2___3___4___5___6___7 *Strongly agree*

Appendix D: Mood Questionnaire

*S:*_____

*D:*___/___/___

Please state the degree to which you are currently experiencing the following states of mood by circling the appropriate numbers:

Pleased	*Not at all*	1 2 3 4 5 6 7	*Very much*
Joy	*Not at all*	1 2 3 4 5 6 7	*Very much*
Gloomy	*Not at all*	1 2 3 4 5 6 7	*Very much*
Glad	*Not at all*	1 2 3 4 5 6 7	*Very much*
Depressed	*Not at all*	1 2 3 4 5 6 7	*Very much*
Frustrated	*Not at all*	1 2 3 4 5 6 7	*Very much*
Enjoyment/Fun	*Not at all*	1 2 3 4 5 6 7	*Very much*
Delighted	*Not at all*	1 2 3 4 5 6 7	*Very much*
Annoyed	*Not at all*	1 2 3 4 5 6 7	*Very much*
Contented	*Not at all*	1 2 3 4 5 6 7	*Very much*
Angry	*Not at all*	1 2 3 4 5 6 7	*Very much*
Fear/Anxiety	*Not at all*	1 2 3 4 5 6 7	*Very much*
Happy	*Not at all*	1 2 3 4 5 6 7	*Very much*
Sad	*Not at all*	1 2 3 4 5 6 7	*Very much*

Appendix E: Smoking History Questionnaire

Name: _____

On average how many cigarettes do you smoke each day? _____

When did you first try smoking a cigarette? _____ Years

How long have you been a regular smoker? _____ Years _____ Months

Have you ever tried to quit smoking? YES/NO

- if "yes" how many times have you tried? _____
- How many times were you successful? _____
- What made you start smoking again?

What is the nicotine content of the cigarettes you smoke? _____

How often do you buy cigarettes? _____

How many do you buy each time? _____

How long after you wake up do you smoke your first cigarette?

Are you presently trying to reduce (cut-down) the amount that you smoke?

YES/NO

APPENDIX F

Appendix G

Fagerstrom Test of Nicotine Dependence[1]

1. How many cigarettes a day do you smoke? (circle one)

10 or less	11 – 15	16 – 20	21 – 25	26 or more

2. How deeply do you inhale? (circle one)

1	2	3	4	5
I do not inhale		Moderately		Very Deeply

3. How often do you smoke more in the morning than the rest of the day? (circle one)

1	2	3	4	5
Never		About half the time		Always

4. How often do you smoke your first cigarette within 30 minutes of waking? (circle one)

1	2	3	4	5
Never		About half the time		Always

5. How difficult would it be for you to give up your usual first cigarette of the day? (circle one)

1	2	3	4	5
Not difficult		Somewhat difficult		Extremely difficult

6. How difficult do you find it to refrain from smoking in places where it is forbidden? (e.g., in church, at the library, cinema, etc.)? (circle one)

1	2	3	4	5
Not difficult		Somewhat difficult		Extremely difficult

7. How often do you smoke when you are sick with a cold, the flu, or are so ill that you are in bed most of the day? (circle one)

1	2	3	4	5
Never		About half the time		Always

8. On average, about how much of each cigarette do you smoke? (circle one)

1	2	3	4	5
_ or less	_	2/3	_	ALL

9. On average, how often do you inhale? (circle one)

1	2	3	4	5
Never		About half the time		Always

10. On average, how often do you hold cigarette smoke in your lungs for a moment or two before exhaling?
(circle one)

1	2	3	4	5
Never		About half the time		Always

1. Heatherton, TF., *et al.* Br. J. Addict. 1991 Sep; 86(9):1119-27