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Sensory imagery in craving: From cognitive psychology to new treatments for addiction

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Abstract

Sensory imagery is a powerful tool for inducing craving because it is a key component of the cognitive system that underpins human motivation. The role of sensory imagery in motivation is explained by Elaborated Intrusion (EI) theory. Imagery plays an important role in motivation because it conveys the emotional qualities of the desired event, mimicking anticipated pleasure or relief, and continual elaboration of the imagery ensures that the target stays in mind. We argue that craving is a conscious state, intervening between unconscious triggers and consumption, and summarise evidence that interfering with sensory imagery can weaken cravings. We argue that treatments for addiction can be enhanced by the application of EI theory to maintain motivation, and assist in the management of craving in high-risk situations.

Sensory imagery in craving:

From cognitive psychology to new treatments for addiction

Sensory imagery refers to our ability to mentally simulate the sight, sound, smell, taste, and feel of an experience. This imagery is emotive in a way that merely thinking about experiences is not: imagining distressing scenes increases anxiety relative to verbally thinking about them (Holmes & Mathews, 2005) while imagining positive scenes increases happiness (Holmes, Lang & Shah, 2008). The advertising industry is well aware of the power that sensory imagery has to motivate consumer behavior. Evocative descriptions of holiday resorts describe 'sun-kissed beaches' and 'turquoise waters'; food packaging lists the contents as 'mouth watering' and 'juicy'. We respond to these positive sensory labels by forming mental images of the target, often in its idealized form, and we are then biased in our decision-making by the assumed properties of the ideal (rather than the actual) product, and by a cascade of affective reactions to our imagery. The power of sensory imagery is also illustrated by its use in laboratory research to stimulate or exacerbate craving for drugs. For example, Tiffany & Hakenewerth (1991) asked cigarette smokers to 'imagine vividly' audio tapes containing either explicit urge-related descriptions of smoking situations or neutral social situations, and found that their physiological responses (heart rate, skin conductance levels) and self-reported desire to smoke increased for the urge scripts compared to the neutral scripts. In a similar study, Tiffany & Drobles (1990) found that more vivid imagery of smoking scenarios was associated with stronger urges to smoke. Likewise, alcohol craving can be induced by asking clients to imagine entering their favorite bar, ordering, holding and tasting a cold, refreshing glass of their favourite beer; guided imagery such as this can be more successful at inducing cravings in the laboratory than actually showing people a real drink (Litt & Cooney, 1999).

We argue in this paper that sensory imagery is a powerful tool for inducing craving because it is a key component of the cognitive system that underpins human motivation in general. Imagery plays an important role in motivation because it conveys the emotional qualities of the desired event, mimicking anticipated pleasure or relief, and continual elaboration of the imagery ensures that the target stays in mind. We contend that craving is a conscious state, intervening between unconscious triggers and consumption, and summarise evidence that interfering with sensory imagery can weaken cravings. We suggest that treatments for addiction can be enhanced by the application of imagery-based approaches to the maintenance of motivation and management of craving.

Elaborated Intrusion theory

The role of sensory imagery in motivation is explained by Elaborated Intrusion (EI) theory (Kavanagh, Andrade & May, 2005; May, Panabokke, Andrade & Kavanagh, 2004). According to this theory (see Figure 1), there are two components in an episode of craving, an initial apparently spontaneous intrusive thought, followed by a cycle of elaborative cognition.

A wide range of stimuli of which we are most likely not focally aware, such as physiological cues (salivation, thirst, tiredness), negative mood, environmental cues, and related thoughts increase the likelihood that we will experience a conscious thought about the target of desire. The thought feels spontaneous, because we have been unaware of the precursor activity, which takes the form of automatic or overlearned associations that do not require conscious control. The thought is intrusive in the sense that, once conscious, it interrupts one's train of thought, but in many cases it may be fleeting, for example when a momentary thought about lunch interrupts an interesting conversation. Even in a sample of people starting to address alcohol-related problems, when we might expect alcohol-related

thoughts to capture attention, 87% reported that these thoughts sometimes popped into mind but then vanished without effort (Kavanagh, May & Andrade, 2009).

Intrusive thoughts only become desires when they are elaborated, as might happen when the thought about drinking coffee interrupts one's attention to a dull lecture. Elaboration includes planning ways of achieving the desire ('I could buy a coffee), generating expectancies about satisfying the desire ('I'd be able to concentrate better once I've had a coffee'), and thinking about one's self-efficacy or ability to obtain the desired object or activity ('I've got the right change for the coffee machine in the lobby'). Importantly, though, elaboration involves sensory imagery. We imagine engaging in the desired activity and the image conveys some of the pleasure or relief of the real thing. We imagine the sort of coffee we will buy, the warmth, smell and taste of it, and the satisfaction of relieving our craving. More vivid and realistic images convey greater pleasure, and help us decide whether we really want an espresso or cappuccino, but they also make us more acutely aware of the separation between our current state and desired state. If the desire thought has arisen in situations where consummation is not immediately possible then this realization can be unpleasant or uncomfortable: if the desire conflicts with higher-order goals about abstinence, then one can feel guilty and weak for wanting it in the first place. Thus desire imagery is briefly pleasurable but, if the desire remains unfulfilled, ultimately aversive. This negative emotion motivates us to achieve our desire and change our current situation.

[fig 1 about here]

Craving as a conscious state

EI theory views sensory imagery as a key component of consciously mediated substance use, as in other motivated behavior. Sensory imagery serves as a mental bridge

between initial transitory thoughts about drug use and actual consumption, assisting with the direction of behavior by constructing potential future events, as well as motivating it. While craving can occur without imagery, it is imagery that gives a sensory experience that accentuates relief or pleasure and feelings of deficit.

Craving for drugs can be triggered by drug-related stimuli in the environment (e.g., drug paraphernalia), related thoughts (e.g., thinking about a friend with whom one uses drugs), physiological withdrawal symptoms, anticipatory responses such as salivation, and negative mood. Negative mood is strongly associated with craving (Sayette & Huford, 1995; Maude-Griffin & Tiffany, 1996; Robbins, Ehrman, Childress, Cornish, & O'Brien, 2000) and may become increasingly important as addiction develops and any negative mood is increasingly misattributed to lack of the drug. Development of attentional biases in addiction (Field & Cox, 2008) increases the likelihood that drug-related stimuli will be processed, and so trigger the intrusive thoughts that lead to substance craving, but there is no direct link. The relationship between attentional biases and craving is weaker than would be expected if a direct, automatic relationship existed (Field, Munafò & Franken, 2009).

Unconscious triggers do not lead directly to consumption but instead increase activation of drug-related information in memory, which in turn increases the likelihood of experiencing a thought about drug use. These intrusive thoughts may be verbal thoughts or image fragments, and may be fleeting (May et al, 2004). Trying to suppress thoughts about consumption tends to exacerbate rather than reduce their occurrence, and also leads to increased consumption, a behavioural rebound (Erskine, 2008). Once a thought has been experienced consciously, then consumption may follow directly with little further thought, if the situation permits; but it is more likely that the substance is not immediately to hand and that actions need to be undertaken to obtain it. This provides the window for elaboration to occur, or for the thought to pass from the person's mind.

While passing thoughts can be experienced keenly, intense craving more typically involves elaboration. In this sense, intrusive thoughts are typically the gateway to prolonged or intense craving. As described above, elaboration includes many cognitive activities, including planning acquisition, evaluating self-efficacy in resisting craving, comparing conflicting goals, and generating expectancies of the effects of consumption. The key component though, and the one that gives elaboration greater emotional bite, is sensory imagery.

Imagining the sight, smell, taste and bodily effects of consuming the substance mimics the sensory experience of actually consuming it. This imagery supports the other aspects of elaboration and provides a mental bridge between the trigger and eventual behavior. Imagery sustains motivation in this way because it is emotionally charged. When a smoker imagines smoking a cigarette, they are not merely imagining what the cigarette would look like and taste like, they are also imagining how pleasurable the taste and effects of inhalation would be. An alcoholic anticipating the first drink of the day not only visualizes the drink but, by doing so, experiences the same pleasure or relief expected from actually drinking it. The pleasure or relief felt when imagining substance use may be weaker than the real thing – a mere simulacrum – but at times it may be even stronger because imagery allows us to mentally conjure up our ideal experience, where substance use is perfectly rewarding and lacks the inconveniences of everyday life, such as having to stand outside in the rain to smoke a cigarette. One smoker has pointed out to us that their imaginary cigarette is always the best cigarette they have ever had, and is better by far than the subsequent experience.

The pleasure or relief embodied by the initial image encourages further imagery, but imagery also has aversive effects. Imagery enhances awareness of deficit, as when a smoker imagines the satisfaction of taking a drag on a cigarette and, by comparison of their imagined and actual state, feels more keenly their current discomfort and lack of satisfaction. The

ensuing worsening of mood stimulates further, increasingly vivid and realistic imagery in a downward spiral of briefly pleasurable imagery leading to enhanced awareness of deficit and worsening mood.

Substance use often persists in the face of good intentions to quit. The central role of sensory imagery in craving and substance use helps to explain the relative weakness of our good intentions. Distant or abstract goals to change our lives, for instance to become healthier, can usually be imagined less vividly than can habitual behaviours, because we have less information in memory to draw on, and in particular little sensory information on which to base an image of an ideal future self that we have never before experienced. This lack of sensory information means that goals to become healthier are difficult to imagine vividly. Images of habitual substance use are more concrete and proximal, making them more vivid and more salient or urgent when faced with a choice to give into an urge to use substances, or to resist temptation for better future health.

Sensory imagery is a consistent feature of people's subjective reports of their craving experiences (Salkovskis & Reynolds, 1994; May et al., 2004; Statham, Connor, Kavanagh, et al., under review). Imagery (of sights, tastes, smells, physical sensations and sometimes sounds) is reported as a feature of craving for a range of addictive (May et al 2004; Kavanagh, May & Andrade, 2009) and non-addictive substances (Harvey, Kemps & Tiggemann, 2005) and activities (May, Andrade, Kavanagh & Penfound, 2008). Elaborating sensory imagery not only extends episodes of craving—it makes the craving more intense, as the images become more articulated and vivid. Particularly in the case of visual imagery, the strength or vividness of imagery, and the frequency of imagery, correlates with craving strength. For example, Kavanagh et al. (2009) found that most people with alcohol problems have sensory imagery during their strongest craving episodes when they are trying to control their alcohol use, with their imagery combining more than two senses on average. The most common elements of

alcohol imagery are imagining tasting a drink, picturing the drink, and imagining swallowing alcohol. As predicted by Elaborated Intrusion theory, frequent sensory imagery is associated with stronger and longer-lasting episodes of craving for alcohol.

Automatic and controlled cognitive processes in addiction

In contrast to EI Theory's conscious role for craving, there is a strong tradition within psychology of seeing addictive behaviors as automatic or conditioned, learned initially through the positively reinforcing aspects of drugs' positive or euphoric effects and subsequently through negative reinforcement of withdrawal reversal. More recently, the incentive-sensitization model argues that addiction to drugs develops through sensitization of the brain's reward system to drug-related stimuli through the neurological effects of the drugs themselves (Robinson & Berridge, 1993). This supports an increased salience of the drug-related stimuli and the development of highly conditioned responses, leading to 'wanting' that has no conscious component, although Berridge and Robinson (2003) suggested that vivid cognitive images of reward might also activate 'wanting', as if they were themselves drug-related stimuli.

Sometimes, exposure to conditioned stimuli is sufficient to trigger drug use with minimal conscious oversight and little or no craving, as when a smoker absent-mindedly lights another cigarette before finishing the current one. In this situation substance use is automated, with behavior driven by automatically activated action schemas without intervention from top-down control processes. Tiffany's (1990) theory sees craving as an epiphenomenon resulting from the conscious effort required to either inhibit these automated action schemas (in the case of abstinence attempts) or to seek solutions when their completion is prevented by the environmental or situational context. In Tiffany's model, craving does not

directly cause consumption, but results from consumption's impossibility; its negative connotations still serve as a motivating factor to complete the schema and satisfy the desire.

We would also argue pragmatically that situations where consumption can be carried out automatically, without conscious action, are rare, because substance use usually requires more complex sequences of behaviors over extended time periods. Conscious mediation is needed to orchestrate these sequences of behavior and to carry them out in the face of competing goals. While smokers may have a packet to hand and be able to light up a cigarette without conscious awareness of having done so, they are an unusual exception. A more typical instance of substance use might involve planning (a telephone call to a drug dealer, a trip to a bar or shop, a break from work), during which the individual may have thoughts assessing self-efficacy ('can I resist it?'), or generating expectancies ('it'd feel great right now'), and have to engage in the inhibition of competing goals (to be healthier, to save money, to finish a piece of work).

Sensory images are the medium by which we keep in mind the goal of obtaining a drug during this extended sequence of thoughts and actions, and the medium by which we comparatively evaluate and prioritise competing goals. If the elaboration of these images stops, then the conscious episode of craving ends: unconscious activation of drug-related memories and concepts remains, ready to trigger another episode, but until then the individual can pursue other goals.

Clues to tackling craving imagery

The cognitive psychology of mental imagery explains how imagery can be prevented or weakened, while research into craving shows how preventing or weakening mental imagery can lead to reductions in craving.

Mental imagery involves activation of the same brain regions that are activated by actual perception (Kosslyn, Thomson, Kim and Alpert, 1995). Thus, neuroimaging studies show increased activity in visual areas of the brain when participants are seeing an object and when they are picturing an object. This mental 'seeing' also requires retrieval of information from long-term memory (generic knowledge of an object's shape and color, for instance, and specific memories of having seen such objects before), generation of an image from the information thus retrieved, and maintenance of that image in consciousness. Retrieval, image generation, and maintenance are carried out by a set of cognitive processes that are collectively known as 'working memory' (Baddeley, 1986; Baddeley 2000). Neuroimaging studies show increased activation in brain regions that support working memory during substance craving (e.g., Grant et al, 1996).

Working memory is the means by which we are able to keep information consciously in mind while transforming it or using it to achieve some goal. For example, when mentally adding up a shopping bill we use working memory to hold or 'carry' subcomponents of the sum; when planning a route, we use working memory to visualize landmarks and links between them. In craving, working memory is involved when we recollect where we put our cigarettes, work out if we have time to stop and smoke one, and visualize taking a cigarette out of its packet and lighting it.

Sub-systems of working memory are specialized for processing auditory or visuospatial information. Imagining the appearance of a bartender pouring a drink uses visuospatial working memory while imagining the clatter of coins as you win the slot machine jackpot uses auditory working memory. There is a limit to how hard these working memory systems can work. Using visual working memory to remember and tap a pattern on a keyboard, for example, makes it harder to imagine a visual scene such as a busy train station or a rose garden, and such images are rated as less vivid than when participants are doing an auditory

task that does not impinge on the visual working memory processes needed for visual imagery (Baddeley & Andrade, 2000). This limited capacity is seen across a range of imagery tasks, from imagining verbally cued neutral scenes as in this example, to keeping recently perceived stimuli vividly in mind, to recollecting personal experiences. Even highly emotive autobiographical memories feel less vivid and less distressing (or less pleasurable) if they are recalled while performing a task that loads working memory (Kavanagh, Freese, Andrade & May, 2001; van den Hout, Muris, Salemink, & Kindt, 2010; van den Hout, Englehard, Smeets, et al 2010).

Working memory is required for the conscious cognitions that constitute craving, from the elaboration of plans to acquire a substance to trying to focus on competing goals and inhibit thoughts about substance use. Not surprisingly, people perform less well on a range of working memory tasks when they are craving than when they are satiated (Kemps, Tiggemann, & Grigg, 2008). There is a two-way relationship, thus people crave food and drugs less strongly when they carry out tasks that require working memory than when they have nothing else to do.

For clinical purposes, maintaining a perpetual, general working memory load sufficient to block craving is impractical, because it would block most normal cognitive activity as well as craving. Instead, this area of craving research has focused on simpler tasks that selectively compete with aspects of working memory needed for craving imagery. The aim is to blunt the craving or provide a brief respite rather than eliminating it altogether.

The limited capacity of working memory is the clue to reducing craving by reducing craving imagery. As the visuospatial and verbal subsystems of working memory can only hold and process a certain amount of information at a time, occupying them with a simple visual or verbal task is sufficient to inhibit visual or auditory imagery. In most substance use,

auditory imagery is less likely than visual, gustatory or olfactory imagery, unless sounds are highly associated with the person's preferred substance (e.g. the sound of popping champagne, the fizz of the wine, chinking glassware). Experimental studies have often therefore compared the effects on craving of performing visual working memory tasks versus auditory or verbal tasks that control for generic working memory factors and allow us to test the specific effects of blocking visual imagery. Tasks that involve manipulating, remembering or imagining visual information make it difficult to visualize drug use simultaneously, and have been shown to lead to lower craving than verbal tasks that permit concurrent sensory imagery.

Imagining neutral scenes (e.g., a rose garden) as opposed to neutral sounds (e.g., a telephone ringing) reduces cigarette craving in abstinent smokers to the levels reported by smokers who are allowed to smoke ad lib before the experiment. Imagining neutral odors is also effective (Versland & Rosenberg, 2007). Imagery tasks are not the only ways of blocking craving imagery; it can also be achieved with non-imagery tasks that also require visuospatial working memory processes. For example, the development of cigarette craving is inhibited by asking participants to create specific forms out of modeling clay or plasticine (spheres, or cubes, or animal shapes) while their hands are out of sight (May et al., 2010; Andrade, Pears, May & Kavanagh, under review). This clay modeling task involves the maintenance of a visual representation of the intended shape in working memory, as well as spatiomotor control processes that are also involved in rehearsal (Stuart, Holmes & Brewin, 2006), and has been shown to prevent encoding of visually traumatic films into memory, resulting in fewer subsequent intrusive memories for the films.

Effects of selective cognitive blockade on craving have also been tested in relation to craving for food, either with hungry participants craving food in general or with participants craving chocolate, which is associated with rather specific cravings that cannot be satisfied by

nutritionally similar foods (Michener & Rozin, 1994). This research has shown that craving can be reduced by imagining neutral scenes (May et al 2010), by watching a rapidly changing visual display (May, Andrade, Pannabokke & Kavanagh, 2010; Steel, Kemps & Tiggemann, 2006), and by performing tasks that require spatiomotor control as well as visual working memory processes, for example making side to side eye movements or tapping a pattern on a keyboard (McLelland, Kemps & Tiggemann, 2006). The similarity in effects on food craving and cigarette craving supports the argument that substance craving in general can be reduced by selectively blocking visuospatial working memory.

One study has paradoxically shown that imagining eating a chocolate sweet thirty times can also reduce the desire for chocolate, compared to imagining putting a coin in a slot machine (Morwedge, Huh, & Vosgerau, 2010). This appears to be due to habituation, with the repeated image losing its emotive power over the course of the task, in much the same way that actually eating thirty chocolate sweets would exhaust their appeal, or saying a word over and over dissociates it from its meaning. While effective in controlled settings, however, it is difficult to see how this could easily be applied in practical settings.

Functional Decision Making: An imagery-based intervention

Craving is an important target for substance use treatments because it helps to sustain addictive behaviours (more cigarettes are smoked 'to relieve craving' than for any other reason; Carter, Lam, Robinson, et al., 2008) and makes quitting difficult. Intense craving can occur long after physiological withdrawal symptoms have faded (e.g. because of exposure to previously conditioned cues), inducing discomfort and distress and increasing the likelihood of relapse. It is an important trigger of relapse in people who have quit smoking (Killen & Fortmann, 1997; Shiffman, Engberg, Paty, et al., 1997; Zhou, Nonnemaker, Sherrill et al., 2009). Psychological treatments are effective generally in addiction, both on their own and

combined with pharmacological treatments, but there is much room for improvements in treating craving during the quit attempt and providing better tools to help clients cope with recurrences of craving after quitting.

Over the last three decades, motivational interviewing (MI; Miller, 1983; Miller & Rollnick, 2002) has progressively gained empirical support (Dunn, Deroo & Rivara, 2001). Using client-centred methods, it encourages people to explore their ambivalence towards change, and consider their potential for success in an attempt. While it has been applied to engage people in treatment, it has also been used as a stand-alone treatment. In the largest randomised controlled trial on alcohol misuse to date, a four-session version of MI (Motivation Enhancement Therapy, MET) gave similar outcomes in the large-scale Project MATCH alcohol treatment study, to ten sessions of cognitive-behaviour therapy or twelve-step therapy (Project MATCH Research Group, 1997). However, effects on substance use are often somewhat modest (Hettema & Hendricks, 2010), leaving opportunities to increase impact.

Based on EI theory and other recent developments, we suggest several ways in which a motivational approach may be made more powerful. We call the new approach “Functional Decision Making” (FDM). It can be seen as a systematic generalization of MI into the natural environment—training people to use similar strategies to the clinic-based MI, when they are tempted to engage in dysfunctional behaviour. This approach addresses the problem mentioned above—the difficulty in developing a rational balance of the pros and cons of dysfunctional behaviour to mind, when faced with temptation.

MI helps people to become more aware of their ambivalence towards substance use. However, it is important to recognise that this ambivalence becomes clearer when considered through time—on Friday evening, it is harder to think about the downsides of alcohol than on Saturday morning. As noted earlier, this is partly because positive aspects of behaviour

control are harder to visualise on Friday evening, but also it is because images about alcohol are at least initially rewarding, but images of hangovers are not. The generation of imagery about alcohol and its consumption consume working memory capacity, and make it more difficult to form a rational decision.

How then can the salience of alternative goals be enhanced? Part of the answer may be to provide more rehearsal in MI sessions. MI already uses repeated summaries, often by the participant, and that presumably aids in later recall as well as assisting in the session itself. Further rehearsal may provide additional benefit. Cueing recall of the advantages of behaviour control (e.g. by cue cards, and by presenting memorable images to aid subsequent imagery elaboration) may also enhance the salience of competing motivations. Furthermore, MI is in essence hypothetical—it encourages participants to guess about potential advantages of behaviour change. Tracking actual positive outcomes and rehearsing those is likely to assist with maintenance. MI already uses cognitive therapy techniques, to help people question whether the perceived disadvantages of behaviour control always occur, and are necessarily as powerful as the person currently expects (e.g. does alcohol always make you more sociable?). A further focus of the subsequent monitoring is to continue to test overly positive assumptions about substance use in subsequent weeks. A final feature of this initial set of enhancements is to focus on advantages of change rather than disadvantages of current use, since there is a risk that some of the latter are not amenable to change, and related ruminations may have counterproductive impacts (e.g. “A downside of my alcohol use is that my wife left me—I guess that’s a further reason to drink—at least I’ll forget about it”). Accordingly, summaries, rehearsal and elaborations of outcomes concern areas that are likely to improve (e.g. “I’ll be more attractive to women if I’m not drunk”).

EI theory offers further suggestions for development of functional decision making in the natural environment. Because both craving and the decision to use substances is

essentially a conscious, cognitive phenomenon, it is susceptible to interference from ongoing cognitive activities. The laboratory studies discussed in this paper suggest a range of simple tasks that might be useful for controlling craving: tasks that selectively engage processes of visuospatial working memory. Extrapolating to everyday life, craving should be reduced by spending a few minutes vividly recollecting a happy memory or scene, making models from a piece of some malleable substance, or even watching a screensaver with high contrast, continually changing visual properties.

FDM takes this a step further. Rather than using any positive image to interfere with craving imagery, it uses multi-sensory images of the advantages of behaviour control, and of pleasurable goals that are inconsistent with substance use. As already noted, the disadvantages of substance use are aversive to rehearse, and are likely to be avoided, while distal positive outcomes of control are often less vivid, and may correctly be seen as less certain. Accordingly, the focus of FDM is on imagery about proximal, valued and probable outcomes of control that are individualised for each person—e.g. feeling physically alert when driving home or at work the next morning. When positive outcomes of control are experienced, these are rehearsed in imagination, and projected into the future (e.g. a grudgingly positive response by the person's partner is used to image the relationship continuing to improve over successive weeks and months of substance control). Since novel, episodic imagery is more effortful and more demanding of working memory, the emphasis of all the rehearsed imagery is on variations of unfolding past and future events, rather than on static, unchanging pictures. The imagery should also avoid cueing the substance use: so, it focuses on unfolding events that do not involve substance-use contexts or activities. We are currently conducting trials of FDM, to demonstrate its ability to enhance other motivational methods.

Thought acceptance and mindfulness

FDM deals with disrupting the link between intense desire and substance use. A further focus of EI-based treatment is potentially at an earlier stage, disrupting the tendency of intrusions to trigger elaboration.

Simple thought suppression is counterproductive, due to ironic effects of thought monitoring (Wegner, Schneider, Carter & White, 1987). A more effective strategy may be to use acceptance-based or meditation mindfulness (Kabat-Zinn, 2003), which encourages individuals to view thoughts as transient events and to accept that unwanted thoughts will sometimes pop into mind. Letting thoughts come and go again breaks the cycle of attempted thought suppression, increased thoughts, feelings of failure or rumination on the thoughts, and renewed but counterproductive suppression. In addiction, the aim is to help participants see that there is no need to elaborate a thought about substance use, because it will go again of its own accord. A thought about a substance is not as a sign that they need and must have the substance, but is just a thought.

Mindfulness-based therapies teach individuals to become aware of their whole, changing, sensory experience. Training in mindfulness aims to increase awareness of all thoughts and sensations, and thereby decrease the salience, and elaboration of, unwanted thoughts. Mindfulness-based interventions also reduce distress about the craving, by helping the person observe their thoughts without engaging with them or being concerned about what they may mean. Bowen, Witkiewitz, Dillworth et al (2006) found that prison inmates who took part in a mindfulness course while incarcerated reported significantly less use of alcohol, cocaine and marijuana in the three months following their release. Witkiewitz & Bowen (2010) reported that craving mediated the relationship between negative affect (depressive symptoms) and alcohol or drug use in a control group of substance abusers undergoing

treatment as usual, but that this relationship was abolished in an experimental group undergoing mindfulness based intervention. Zgierska, Rabago, Chawla et al., (2009) conducted a systematic review of the efficacy of mindfulness meditation based interventions for substance use disorders, and found that the majority showed positive outcomes compared to baseline or other therapy, although the variety of interventions made a definitive conclusion premature. Of particular relevance for our argument, this review noted that the mindfulness approaches differed to conventional cognitive behavioural therapies through the focus upon providing the client with the skills to control their responses to thoughts, rather than targeting antecedent cues in an attempt to reduce substance related thoughts.

Future directions for craving interventions

Mindfulness training includes strategies such as body scanning that help increase awareness of experiences and thoughts other than the unwanted ones. Body scanning involves shifting attention from one part of one's body to another, a process that is likely to involve visual imagery of the attended parts of the body. Recent studies have shown that body scanning reduces intrusive thoughts about food as effectively as a distraction technique involving guided sensory imagery of a woodland walk (May, Andrade, Berry, Batey, Kavanagh 2010) , and that it reduces desire to smoke compared with listening to a natural history tape, and that it can be used effectively by people at home, when unsupervised (Ussher, Croyley, Playle, Mohidin & West 2009). These studies used pre-recorded audio tapes, but with practice people can conduct body scanning without such aids, and future research could evaluate the effectiveness of self-guided body scanning in reducing cravings.

Interventions like body scanning that combine positive or neutral sensory imagery, or blockade of visuospatial working memory, with acceptance of intrusive thoughts should be particularly effective at reducing craving because they should reduce the likelihood of

intrusions being elaborated while simultaneously reducing the vividness of any sensory imagery that does occur, breaking the vicious circle whereby intrusive thoughts trigger sensory imagery which in turn triggers further thoughts.

Conclusions

Sensory imagery is central to craving, providing its emotional bite and prolonging episodes of craving in the face of competing desires to abstain. Stronger, more vivid imagery predicts stronger craving, while blocking imagery with specific competing tasks has been shown to reduce craving. The development of substance craving can be inhibited by clinical interventions that disrupt the elaboration of intrusive thoughts and block ensuing sensory imagery. We anticipate that Functional Decision Making, based on multi-sensory imagery of personally relevant positive aspects of behaviour control, will enhance the individual's ability to avoid dysfunctional behaviour at the critical moments when they are most tempted.

References

- Andrade, J., Pears, S., May, J. & Kavanagh, D.J. (under review) Use of a clay modeling task to reduce chocolate craving.
- Baddeley, A. D. & Andrade, J. (2000). Working Memory and the vividness of imagery. *Journal of Experimental Psychology: General* 129(1): 126-145.
- Baddeley, A. D. (1986). *Working memory*. Oxford: Oxford University Press.
- Baddeley, A. D. (2000) The episodic buffer: a new component of working memory? *Trends in Cognitive Science*, 4(11) 417-423.
- Berridge, K. C., & Robinson, T. E. (2003). Parsing reward. *Trends in Neuroscience*, 26, 507–513.

- Breslin, F. C., Zack, M., & McMMain, S. (2002). An information-processing analysis of mindfulness: Implications for relapse prevention in the treatment of substance abuse. *Clinical Psychology: Science and Practice, 9*, 275–299.
- Carter, B. L., Lam, C. Y., Robinson, J. D., Paris, M. M., Waters, A. J., Wetter, D. W., et al. (2008). Real-time craving and mood assessments before and after smoking. *Nicotine & Tobacco Research, 10*, 1165–1169.
- Dunn, C., Deroo, I., Rivara, F. P. (2001). The use of brief interventions adapted from motivational interviewing across behavioural domains: A systematic review. *Addiction, 96*, 1725-1742.
- Erskine, J.A.K. (2008) Resistance can be futile: Investigating behavioural rebound. *Appetite 50*, 415-421.
- Field, M., & Cox, W. M. (2008). Attentional bias in addictive behaviors- A review of its development, causes, and consequences. *Drug and Alcohol Dependence, 97*, 1-20
- Field, M., Munafò, M.R., & Franken, I.H.A. (2009) A meta-analytic investigation of the relationship between attentional bias and subjective craving in substance abuse. *Psychological Bulletin, 135*(4), 589-607
- Grant, S., London, E. D., Newlin, D. B., Villemagne, V. L., Liu, X., Contoreggi, C., et al. (1996). Activation of memory circuits during cue-elicited cocaine craving. *Proceedings of the National Academy of Sciences, USA, 93*, 12040–12045.
- Harvey, K., Kemps, E., & Tiggemann, M. (2005) The nature of imagery processes underlying food cravings. *British Journal of Health Psychology, 10*, 49-56.
- Hettema, J. E., Hendricks, P. S. (2010). Motivational interviewing for smoking cessation: A meta-analytic review. *Journal of Consulting and Clinical psychology, 78*, 868-884.
- Holmes, E. A., Lang, T. J. & Shah, D. M. (2008). Developing interpretation bias modification as a “cognitive vaccine” for depressed mood: Imagining positive events makes you feel better than thinking about them verbally. *Journal of Abnormal Psychology, 118*, 76-88.
- Kabat-Zinn J. (2003). Mindfulness-based interventions in context: Past, present, and future. *Clinical Psychology: Science and Practice, 10*, 144-156.

- Kavanagh, D.J., Andrade, J., & May, J. (2005). Imaginary relish and exquisite torture: The elaborated intrusion theory of desire. *Psychological Review*, *112*, 446-467.
- Kavanagh, D. J., Freese, S., Andrade, J., & May, J. (2001) Effects of visuospatial tasks on desensitization to emotive memories, *British Journal of Clinical Psychology*, *40*, 267-280.
- Kavanagh, D. J., May, J., & Andrade, J. (2009). Tests of the elaborated intrusion theory of craving and desire: Features of alcohol craving during treatment for an alcohol disorder, *British Journal of Clinical Psychology*, *48*, 241-254.
- Kemps, E., Tiggemann, M., & Grigg, M. (2008). Food cravings consume limited cognitive resources. *Journal of Experimental Psychology: Applied*, *14*, 247-254.
- Killen, J. D., & Fortmann, S. P. (1997). Craving is associated with smoking relapse: Findings from three prospective studies. *Experimental and Clinical Psychopharmacology*, *5*, 137-142.
- Kosslyn, S. M., Thompson, W.L., Kim, I.J., & Alpert, N.M. (1995) Topographic representations of mental images in primary visual cortex. *Nature* *378*: 496-8.
- Litt, M. D. & Cooney, N. L. (1999) Inducing craving for alcohol in the laboratory. *Alcohol Research and Health*, *23*(3) 174-178.
- Maude-Griffin, P. M., & Tiffany, S. T. (1996). Production of smoking urges through imagery: The impact of affect and smoking abstinence. *Experimental and Clinical Psychopharmacology*, *4*, 198–208
- May, J., Andrade, J., Panabokke, N., & Kavanagh, D. (2010). Visual imagery tasks suppress craving for cigarettes. *Behaviour Research and Therapy*, *48*, 476-485.
- May, J., Andrade, J., Batey, H., Berry, L-M., & Kavanagh, D. J. (2010). Less food for thought: Impact of attentional instructions on intrusive thoughts about snack foods. *Appetite*, *17*, 126–137.
- May, J., Andrade, J., Kavanagh, D. & Penfound, L. (2008). Imagery and strength of craving for eating, drinking and playing sport. *Cognition and Emotion* *22*, 633-650.

- May, J., Panabokke, N., Andrade, J., & Kavanagh, D. (2004). Images of desire: cognitive models of craving. *Memory, 12*, 447–461.
- McClelland, A., Kemps, E., & Tiggemann, M. (2006). Reduction of vividness and associated craving in personalised food imagery. *Journal of Clinical Psychology, 62*, 355-365.
- Michener, W. & Rozin, P. (1994) Pharmacological versus sensory factors in the satiation of chocolate craving. *Physiology & Behavior. 56*, 419-422
- Morwedge, C.K., Huh, Y.E., & Vosgerau, J. (2010) Thought for Food: Imagined Consumption Reduces Actual Consumption. *Science 330 (6010)*, 1530-1533.
- Miller, W. R. (1983). Motivational interviewing with problem drinkers. *Behavioural Psychotherapy, 11*, 147-172.
- Miller, W. R., Rollnick, S. (2002). *Motivational Interviewing: Preparing People for Change*. 2nd ed. New York: Guilford Press.
- Project MATCH Research Group (1997). Matching alcoholism treatments to client heterogeneity: Project MATCH posttreatment drinking outcomes. *Journal of Studies on Alcohol, 58*, 7–29.
- Robbins, S. J., Ehrman, R. N., Childress, A. R., Cornish, J. W., & O'Brien, C. P. (2000). Mood state and recent cocaine use are not associated with levels of cocaine cue reactivity. *Drug and Alcohol Dependence, 59*, 33– 42.
- Robinson, T.E. & Berridge, K.C. (1993) The neural basis of drug craving: an incentive-sensitization theory of addiction. *Brain Research, 18*, 247-291.
- Salkovskis, P. M. & Reynolds, M. (1994). Thought suppression and smoking cessation. *Behaviour Research and Therapy 32(2)*: 193-291.
- Sayette, M. A., & Hufford, M. R. (1995). Urge and affect: A facial coding analysis of smokers. *Experimental and Clinical Psychopharmacology, 3*, 417– 423.
- Shiffman, S., Engberg, J., Paty, J., Perz, W. G., Gnys, M., Kassel, J. & Hickcox, M. (1997). A day at a time: Predicting smoking lapse from daily urge. *Journal of Abnormal Psychology, 106*, 104-116.

- Statham, D.J., Connor, J.P., Kavanagh, D.K., Feeney, G.F.X., Young, R.McD., May, J. & Andrade, J. (in submission). Measuring alcohol craving: Development of the Alcohol Craving Questionnaire
- Steel, D., Kemps, E., & Tiggemann, M. (2006). Effects of hunger and visuo-spatial interference on imagery-induced food cravings. *Appetite*, *46*, 36-40.
- Stuart, A.D.P., Holmes, E.A. & Brewin, C.R. (2006). The influence of a visuospatial grounding task on intrusive images of a traumatic film. *Behaviour Research and Therapy*, *44*, 611-619.
- Tiffany, S. T. (1990). A cognitive model of drug urges and drug-use behavior: Role of automatic and nonautomatic processes. *Psychological Review*, *97*, 147–168.
- Tiffany, S.T. & Drobes, D.J. (1991). The development and initial validation of a questionnaire on smoking urges. *British Journal of Addiction*. *86*, 1467-1476.
- Tiffany, S.T. & Hakenewerth, D.M. (1991). The production of smoking urges through an imagery manipulation: Psychophysiological and verbal manifestations. *Addictive Behaviors*. *16*: 389-400.
- van den Hout, M., Muris, P., Salemink, E., & Kindt, M. (2001). Autobiographical memories become less vivid and emotional after eye movements. *British Journal of Clinical Psychology*, *40*, 121-130.
- Ussher, M., Copley, M., Playle, S., Mohidin, R., & West, R. (2009) Effect of isometric exercise and body scanning on cigarette cravings and withdrawal symptoms. *Addiction*, *104*, 1251-1257.
- Van den Hout, M., Englehard, I.M., Smeets, M.A.M., Homsveld, H., Hoogeveen, E., de Heer, E., Toffolo, M.B.J., & Rijkeboer, M. (2010) Counting during recall: Taxing of working memory and reduced vividness and emotionality of negative memories. *Applied Cognitive Psychology*, *24*(3) 303-311.
- van den Hout, M., Muris, P., Salemink, E., & Kindt, M. (2010) Autobiographical memories become less vivid and emotional after eye movements. *British Journal of Clinical Psychology*, *40*(2) 121-130.

- Versland, A., & Rosenberg, H. (2007). Effect of brief imagery interventions on craving in college student smokers. *Addiction Research and Theory, 15*(2), 177-187.
- Wegner, D. M., Schneider, D. J., Carter, S., & White, T. (1987). Paradoxical effects of thought suppression. *Journal of Personality and Social Psychology, 53*, 5-13.
- Zgierska, A., Rabago, D., Chawla, N., Kushner, K., Koehler, R., & Marlatt, A. (2009) Mindfulness Meditation for Substance Use Disorders: A Systematic Review. *Substance Abuse, 30*(4) 266-294
- Zhou, X., Nonnemaker, J., Sherrill, B., Gilsenan, A. W., Coste, F., & West, R. (2009). Attempts to quit smoking and relapse: Factors associated with success or failure from the ATTEMPT cohort study. *Addictive Behaviors, 3*, 365–373.

Figure caption

Figure 1. The Elaborated Intrusion theory of motivation, showing the contribution of triggers (rounded external boxes), intrusive thoughts ('desire thoughts'), and sensory imagery to craving (central square box). Thick arrows show the controlled processing cycle of conscious imagery and associated affect; thin arrows represent automatic influences on desire (reprinted from Kavanagh, Andrade & May, 2005, with permission).

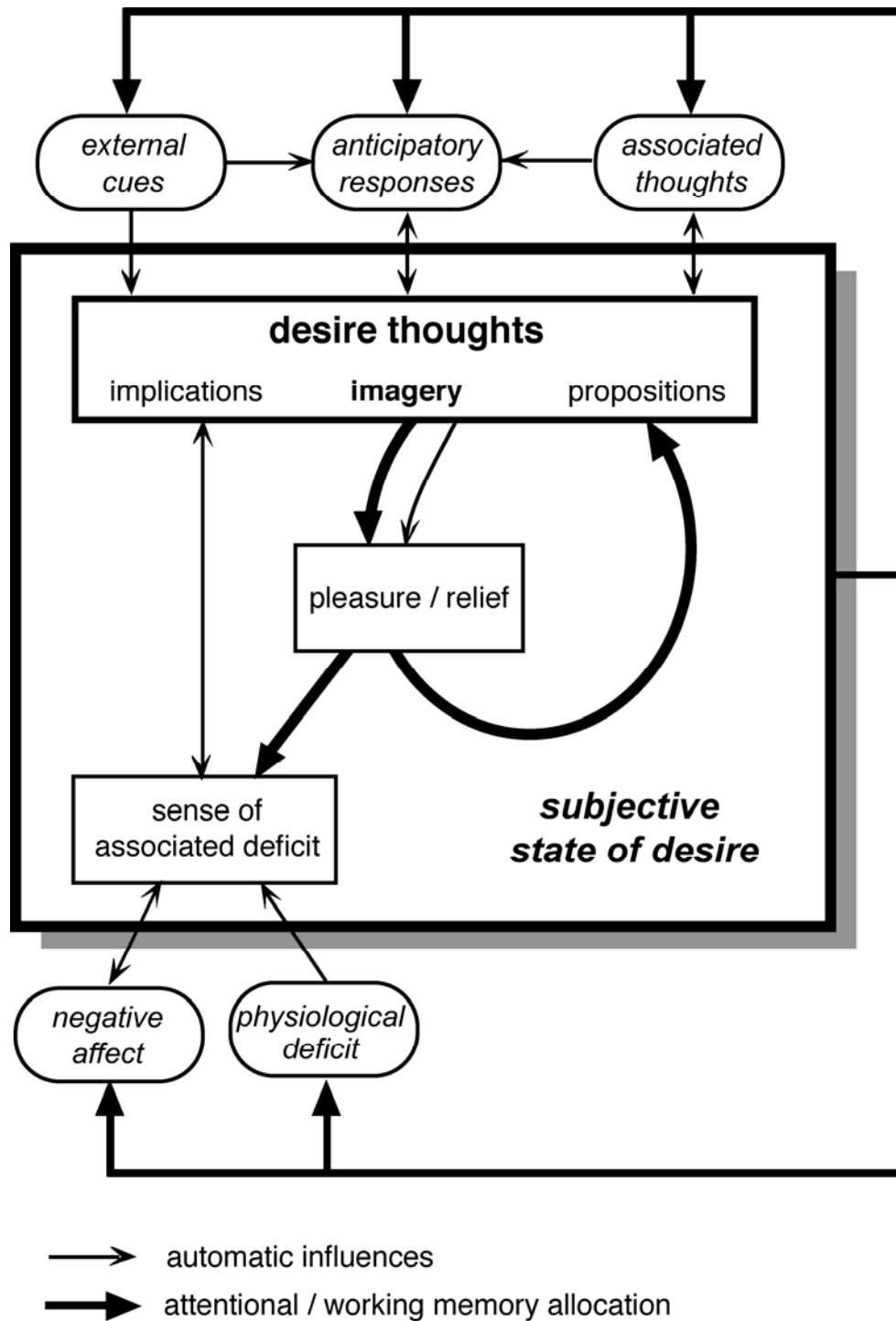


Figure 1