IMPACT OF VIVIDNESS OF SMOKING IMAGERY AND COMPLEXITY OF A TASK ON INTENSITY OF NICOTINE CRAVING

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ABSTRACT

Based on the Elaborated Intrusion theory of desire (Kavanagh, Andrade, & May, 2005), this two-part study was designed to examine whether manipulating smokers’ vividness of cigarette imagery impacted reported craving and whether the complexity of a computer-based visual task differentially reduced craving. In Study 1, we instructed undergraduate smokers (n=39) to imagine smoking-related imagery becoming either more vivid or less vivid (versus no-change control). Manipulating vividness of substance-related imagery had a significant impact on craving measured by Factor 1 (strong desire/intention/smoking as rewarding) of the Questionnaire of Smoking Urges-Brief Version (QSU-Brief; Cox, Tiffany, & Christen, 2001), but had no significant impact on craving measured by Factor 2 (urgent desire/relief smoking) of the QSU-Brief. In Study 2, we instructed undergraduate smokers (n=39) to attend to a relatively-simple versus relatively-complex visual task (versus a no-visual-task control) following two minutes of in situ cue exposure. Engaging in either the simple or complex visual task significantly and equally impacted craving during the intervention (as measured by three retrospective visual analog scales), but did not significantly impact concurrent reports of craving on the QSU-Brief Factors following completion of the intervention. One clinical implication of these findings is that teaching smokers strategies to decrease the vividness of substance-related mental imagery will reduce some aspects of craving, but that engaging in either simple or complex visual tasks warrants further evaluation as an intervention.
This dissertation is dedicated to my family and loved ones for their constant encouragement and support and to Dr. Harold Rosenberg, an exceptional mentor with a wonderful sense of humor.
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IMPACT OF VIVIDNESS OF SMOKING IMAGERY AND COMPLEXITY OF A TASK ON INTENSITY OF NICOTINE CRAVING

INTRODUCTION

Definition of Craving

Many professionals in the field of substance abuse and dependence believe that craving is a key component of addiction. However, despite widespread use of the term and its perceived association with addiction, clinicians and researchers disagree on the definition of craving. Definitions of craving have reflected multiple (subjective, behavioral, cognitive, and physiological) aspects of the craving experience (Mezinskis, Honos-Webb, Kropp, & Somoza, 2001). Whatever the disagreement, craving is generally considered a subjectively and intensely experienced urge, desire, need or compulsion to consume a substance (Drummond, 2001; Merikle, 1999).

Behaviorally, craving may be reflected in the speed with which an individual consumes a substance, the degree to which an individual will perform a boring task to gain access to a substance, or the amount of pain an individual is willing to endure in order to consume a substance. Craving has been described in cognitive terms as intrusive thoughts about a substance (obsessions), anticipation of rewarding effects following consumption, or anticipation of relief from negative effects following consumption. In addition, craving is assumed to be reflected physiologically as increased salivation, rapid heart beat, shortness of breath, perspiration, or an actual sense of tasting, smelling, or feeling the substance.

Craving and Relapse

The importance of craving is rooted in its potential to predict consumption in ongoing alcohol/drug users and relapse in former users. Although the degree to which craving results in
relapse remains unclear, many substance users, clinicians, and researchers assert that craving is a significant factor in relapse (Pickens & Johanson, 1992; Tracy, 1994), perhaps especially in smokers. In a sample of 2,672 smokers ($M_{age} = 42$ years; gender not specified), Killen and Fortmann (1997) found that higher levels of craving immediately following cessation were associated with increased likelihood of relapse (as defined by daily use for at least seven consecutive days) over a one year post-treatment follow-up period. Furthermore, results demonstrated that smokers reporting higher levels of craving relapsed at a notably faster rate. Specifically, although 32% of smokers reporting high levels of craving relapsed in the first week after quitting, only 15% of smokers reporting low levels of craving relapsed during the same time period.

Additional studies provide further support for the association between craving and relapse. Shiffman et al. (1997) instructed 214 smokers ($M_{age} = 42$ years; 59% female) enrolled in a smoking cessation clinic to self-monitor smoking urges for approximately one month following cessation. Findings demonstrated that urge intensity recorded immediately following awaking in the morning was predictive of lapsing (as defined by use of one cigarette) on that day.

Swan, Ward, and Jack (1996) studied the relationship between withdrawal symptoms and relapse in 64 participants attempting to quit smoking ($M_{age} = 41$ years; 63% female). Participants monitored use and withdrawal symptoms (including craving) over a one month period. Results demonstrated that an increase in craving (in addition to increases in anger and depressed mood) was significantly associated with a shorter time to relapse (calculated as the days between quitting smoking and the first occurrence of smoking). Further analyses identified depressed mood and craving as the best combination of predictors of relapse. Craving (but not depressed mood) remained a significant predictor of relapse after adjusting for educational level...
of participants and treatment method (i.e., participating in smoking cessation program versus quitting on one’s own without formal treatment).

**Theories of Craving**

There are currently three general theoretical approaches to explain the phenomenon of craving: classical conditioning approaches, neuroadaptive approaches, and cognitive approaches (Anton, 1999). Almost all models of craving emphasize the role of classical conditioning as a factor in the etiology of craving. Classical conditioning models propose that neutral stimuli or events (e.g., environments in which substances are used, sight of paraphernalia, decreased blood level of drug, emotions), when repeatedly paired with substance use or withdrawal, become conditioned stimuli such that they provoke conditioned psychological and physiological responses previously elicited by intoxication or withdrawal. Some of these psychological and physiological responses are experienced subjectively as craving.

One of the most influential neuroadaptive models of craving (Berridge & Robinson, 1995) holds that repeated use of a substance causes brain systems that mediate incentive-motivation to become hypersensitive to drug stimuli and effects. According to this model, conditioned stimuli (that have been repeatedly paired with substance use) trigger activity in the sensitized neural systems causing exaggerated motivation for the desired substance (i.e., “wanting” or craving). When exposure to conditioned stimuli triggers this “wanting” system, the individual seeks substances, although not always with conscious awareness that one wants or craves the drug effects being sought.

There are several cognitive models of craving. The “cognitive labeling” model posits that craving occurs when external cues induce physical arousal which is interpreted as craving. For example, an individual who often goes to the bar after work to “unwind” may experience an
increased heart rate when she clocks out of work for the evening as well as mental processes identifying the situation as a setting for drinking. According to the cognitive labeling model, she may interpret her arousal as craving for alcohol. Furthermore, according to this model, intensity of craving is dependent on the intensity of the experienced arousal. Thus, subsequent to clocking out of work, if the woman described above feels as if her heart is going to pound out of her chest or explode, she will interpret this as more intense craving than she would if she simply felt slightly out of breath.

Another cognitive model of craving is the “outcome expectancy” model. According to this theory, exposure to drug-related cues triggers expectations about the substance’s psychological and physiological effects. For example, a woman who is dependent on alcohol may see a bar and begin to think that alcohol will make her feel more relaxed and happy. Craving is experienced when these expectancies create a motivation to experience the anticipated positive effects of the substance or to relieve the anticipated uncomfortable effects of withdrawal.

The “dual-affect” model of craving (Baker, Morse, & Sherman, 1986) posits two types of craving: positive affect craving and negative affect craving. Positive affect craving is triggered by positive emotions, cues associated with previous use of the substance, a small dose of the desired substance, and knowledge that the substance is available. According to this model, positive affect craving results in the subjective experience of craving, in addition to drug-seeking, positive affect and physiological responses similar to those that occur when the drug is consumed. Negative affect craving, on the other hand, is triggered by negative emotions, distressing events or physical states (e.g., car accident, withdrawal, lack of access to drug), and
cues associated with previous withdrawal episodes, and results in the subjective experience of craving, drug-seeking, negative affect and withdrawal-like physiological responses.

According to the “dual affect” model, these two types of craving are mutually inhibitory (i.e., only one system – negative affect craving or positive affect craving – can be active at one time). Furthermore, this model posits that memory networks are activated when a person addicted to a substance is exposed to a trigger that has elicited craving in the past. The intensity of this craving increases as the resemblance among the current trigger and previous triggers stored in memory increases. Presumably, increased activation of these memory networks results in increased drug craving and seeking.

One of the most often cited cognitive models of craving is Tiffany’s (1990) cognitive processing approach which proposes that craving is the outcome of conflict between “automated” drug seeking and either environmental or intrapersonal obstacles. According to this model, repeated alcohol or drug use results in “automated” drug seeking and consumption behaviors that are carried out without effort and outside of awareness. These “automated” actions are triggered when alcohol or drug-related cues are present. Craving is proposed to occur when automated behavior is triggered and then obstructed by either environmental or self-imposed barriers. Examples of environmental barriers are lack of resources to purchase a desired substance and lack of transportation to obtain a substance. A self-imposed barrier refers to an abstinence goal, in which one is attempting to abstain from engaging in the automated consumption. Thus, this model holds that alcohol or drug use may occur without craving if seeking or consuming the substance is not impeded by lack of access to the substance or an individual’s motivation to abstain.
In 2005, Kavanagh, Andrade, and May proposed another cognitive model of craving called the Elaborated Intrusion (EI) theory. According to the EI theory, a variety of internal or external cues may trigger intrusive thoughts about alcohol or drugs. Factors that may elicit intrusive thoughts include physiological deficit (e.g., drop in blood alcohol level), negative affect (e.g., depression), external cues (e.g., sight of bar), anticipatory responses (e.g., salivation), and associated thoughts (not explicitly defined). Most intrusive thoughts are transitory and are not experienced as craving. However, when the intrusive thoughts elicit intense positive affective reactions associated with the target substance (i.e., anticipation that consumption of the substance will result in pleasure or relief from withdrawal) or an awareness of deficit, elaboration of the intrusive thoughts will occur. Elaboration refers to attending to and embellishing the intrusive thoughts by seeking relevant internal information (e.g., expectancies about drug effects, memories of drug use, physiological states) and external information (e.g., physical locations or persons from whom the drug might be obtained), which requires use of cognitive resources. According to EI theory, internal and external information are combined in working memory during elaboration to create a sensory image of the substance. This image is initially rewarding, but may become distressing as one becomes more aware of the discrepancy between his/her desired state and actual state.

Research Supporting EI Theory

According to EI theory, mental imagery associated with a target substance (in particular visual imagery) is a key factor contributing to the experience of craving. May, Andrade, Panabokke, and Kavanagh (2004) conducted an investigation that provided support for this claim. These researchers mailed craving surveys to university students, requesting that recipients complete the surveys when experiencing craving for food, tobacco, alcohol, or a non-alcoholic
beverage (e.g., tea, coffee, water, etc.). During the craving episode, recipients were asked to
identify the desired substance that triggered their craving and to rate the strength of their craving
on a 10-point scale ranging from 1 (“very slight”) to 10 (“overwhelming”). Participants were
also instructed to read a list of potential triggers (e.g., felt stressed/anxious/sad, suddenly thought
about it, imagined the smell/taste of it) and rate the degree to which each trigger contributed to
the onset of their craving episode. Finally, participants were instructed to read statements
describing a craving episode (e.g., “having it would feel very comforting right now,” “I am
trying to resist having it,” “I am visualizing it”) and rate the degree to which each statement
described their craving experience.

Of the 361 students who responded (Median age = 20 years; 155 males and 5 unspecified
gender), 219 reported food cravings, 60 reported tobacco craving, 59 reported non-alcoholic
beverage cravings, and 23 reported alcohol cravings. Strength of craving did not differ
significantly across the substances they craved. Participants reported that suddenly thinking
about the substance, feeling discomfort, imagining the taste/smell of the substance, and picturing
themselves having the substance were the strongest triggers contributing to the onset of craving
episodes.

Descriptions rated by participants as most representative of the craving experience
included wanting the substance due to hunger/thirst/exhaustion/physical discomfort, feeling as if
having the substance would feel very comforting at that moment, thinking about how much
better the substance would make one feel, and imagining the taste of the substance. Furthermore,
over 60% of participants reported that imagining the taste of the substance and visualizing the
substance were a part of their craving experience, but only 9% reported hearing themselves
having the substance during a craving episode. Thus, olfactory and visual imagery not only
appear to play a role in triggering thoughts about a substance, but also are reported to be a part of the craving experience.

Taylor, Harris, Singleton, Moolchan, and Heishman (2000) conducted two investigations demonstrating the role of imagery in the production of craving for tobacco. In Experiment 1, 18 participants ($M_{age} = 34$ years; 17 males) were presented six imagery scripts. Imagery scripts described situations in which the participant experienced either an urge to smoke (urge content) or no urge to smoke (without urge content). After each imagery script was read to the participant, participants were instructed to engage in active imagery for 30 seconds and complete measures of craving. Results demonstrated that imagery scripts containing urge content produced significantly greater ratings of tobacco craving than scripts without urge content.

In Experiment 2, Taylor et al. (2000) modified scripts to include a no-urge script, low-urge smoking script, and high-urge smoking script (the rest of their procedure remained identical to that utilized in Experiment 1). Results demonstrated that tobacco craving increased in an orderly fashion as a function of urge intensity. Specifically, craving in the low-urge and high-urge script conditions was significantly greater than craving in the no-urge condition. Furthermore, craving in the high urge-condition was significantly higher than craving in the low urge-condition.

Other studies support the EI-based premise that mental imagery is a key component of craving by demonstrating that imagery tasks unrelated to a desired substance reduce craving. Panabokke, May, Eade, Andrade, and Kavanagh (unpublished manuscript) conducted two investigations demonstrating the role of mental imagery in the reduction of craving for cigarettes. Experiment 1 consisted of 40 smokers ($M_{age} = 25$ years; 18 males). Participants who were asked to refrain from smoking prior to the experiment were exposed to a multi-sensory urge induction
script (i.e., description of a craving situation for smokers) and asked to complete a baseline measure of craving and mood. Then, participants were exposed to either an auditory imagery task, in which they were instructed to form specific auditory mental images (e.g., imagine the sound of a telephone ringing/game of tennis), or a visual imagery task, in which they were instructed to form specific visual mental images (e.g., create a mental picture of a telephone/game of tennis). Participants engaged in three imagery-task trials and completed measures of mood, craving, and vividness of cued imagery subsequent to each trial.

Results demonstrated that nicotine-deprived participants who engaged in the visual imagery task showed an immediate reduction in cigarette craving and completed the study with the lowest craving rating relative to that of the other groups. Craving scores of deprived participants assigned to the auditory imagery group did not change significantly throughout the experiment, suggesting that, unlike visual imagery, auditory imagery does not reduce craving.

In Experiment 2, Panabokke et al. replicated their initial investigation with another 40 smokers ($M_{age} = 31$ years; 24 males) but included additional components to the aforementioned imagery tasks. Specifically, a Dynamic Visual Noise (DVN) display (known to interfere with visual imagery), in which black and white squares appeared randomly on a computer screen, was added to the auditory imagery condition. A Static Visual Noise (SVN) display (which does not interfere with visual imagery), in which black and white squares remained in the same position on the screen, was added to the visual imagery condition. Results demonstrated that craving decreased in nicotine-deprived participants regardless of condition (auditory-plus-DVN versus visual-plus-SVN). Because auditory imagery alone did not reduce craving in the first experiment, Panabokke et al. attributed reduction of craving in the auditory-plus-DVN condition to the DVN task. Furthermore, Panabokke et al. suggested that general distraction does not
reduce craving as evidenced by failure of an auditory imagery task (without the DVN component) to reduce craving. Together, the findings from these experiments suggest that visual imagery, in particular, may be an effective technique to reduce the experience of craving in deprived smokers.

Versland and Rosenberg (unpublished manuscript) also demonstrated the role of mental imagery in the reduction of craving for cigarettes. Fifty-four college students were exposed to the sight and smell of a burning cigarette to elicit craving. Participants then undertook one of four imagery interventions: an olfactory beach imagery condition (in which participants were instructed to imagine the smells associated with a beach), a visual beach imagery condition (in which participants were instructed to imagine the sights associated with a beach), a combination olfactory-plus-visual beach imagery condition, and a cognitive distraction control condition (in which participants were instructed to count down by sevens from the number 500). Participants were then asked to complete a craving questionnaire and to rate the vividness of their imagery.

Although participants in all 4 conditions reported lower craving during the intervention task, participants in the three imagery conditions (i.e., the olfactory beach imagery condition, visual beach imagery condition, and combined olfactory-plus-visual beach imagery condition) reported significantly less craving than participants in the cognitive distraction control condition. Furthermore, the three sensory imagery conditions resulted in equivalent reductions in craving. While this seems to contradict Panabokke et al.’s conclusion that visual imagery is more effective at reducing the experience of craving relative to other forms of imagery (i.e., auditory imagery), it is important to note that majorities of participants in each of the three imagery conditions reported experiencing forms of sensory imagery that were not explicitly described in their assigned imagery condition.
Harvey, Kemps, and Tiggeman (2005) demonstrated the role of imagery in both the production and reduction of food craving. Specifically, Harvey et al. asked 120 female students ($M_{age} = 21$ years) about their dieting status (i.e., currently on a diet to lose weight versus not currently on a diet to lose weight) and randomly assigned both dieters and non-dieters to one of 2 conditions (i.e., favorite food induction scenario versus favorite holiday induction scenario).

Subsequent to exposure to the food or holiday scenario, participants were instructed to rate the vividness of their mental image of the scenario and the level of their food craving. Participants were then randomly assigned to complete an auditory or visual imagery task such that an equal number of participants in the food scenario and holiday scenario participated in each task. Participants in the visual imagery task condition were instructed to imagine the appearance of different visual images (e.g., appearance of a rainbow), while participants in the auditory imagery task condition were instructed to imagine the sound of different auditory cues (e.g., sound of a telephone ringing). Subsequent to completion of the auditory or visual imagery task, participants were instructed to rate both the vividness of the imagery they produced during the imagery task and their level of food craving.

As expected, dieters reported greater increases in craving following exposure to food imagery relative to non-dieters. Results also demonstrated that, although intensity of food craving decreased after exposure to either visual or auditory imagery, intensity of food craving decreased significantly more following exposure to visual imagery. Furthermore, food craving and vividness ratings of food-related mental imagery were significantly and positively correlated, indicating that stronger cravings were associated with more vivid food images.

Kemps, Tiggemann, Woods, and Soekov (2004) conducted two studies demonstrating the role of imagery in the production and reduction of food craving. In the first study, 48 female
undergraduates ($M_{age} = 22$ years) were exposed to a series of both food-related pictures (e.g., chocolate products, ice cream) and non-food pictures (e.g., clothing, electrical appliances). After exposure to each picture, participants were asked to form a mental image of the picture and retain the image for 8 seconds. During retention of the image, participants either looked at a blank computer screen (control condition) or performed one of three visuospatial tasks. In the eye movement visuospatial task, participants were instructed to move only their eyes to focus on a white square that was presented on alternate sides of the computer. In the dynamic visual noise condition, participants were instructed to watch a matrix of boxes that flickered on the computer screen. In the spatial tapping task, participants were instructed to watch a blank computer screen while tapping (in a clockwise direction) four keys arranged in a square pattern.

Participants were then asked to rate the vividness of the mental picture (response choices ranged from “no image at all” to “image perfectly clear—as vivid as normal vision”) and their food craving intensity (response choices ranged from “no desire or urge to eat” to “extremely strong desire or urge to eat”). Results demonstrated that exposure to food-related pictures and instruction to form and retain mental images of these pictures produced more vivid imagery (relative to instruction to form and retain mental images of non-food pictures) and elicited food cravings. Kemps et al. also demonstrated that engaging in concurrent visuospatial tasks (in particular eye movement and dynamic visual noise tasks) significantly reduced both the vividness of neutral and food-related mental imagery and the intensity of self-reported food craving.

In a second experiment, Kemps et al. (2004) used an identical experimental design and procedure to examine the impact of verbal cues (as opposed to pictorial cues) representing food-related and non-food topics. Specifically, instead of presenting participants with pictures and
instructing them to form and retain a mental image of the stimulus in their mind, Kemps et al. asked participants to create mental images based on verbal cues. Results demonstrated that exposure to food-related verbal cues and instruction to form and retain mental images of these cues elicited food cravings. Similar to the first experiment, results demonstrated that visuospatial tasks (i.e., eye movements, dynamic visual noise, spatial tapping) reduced both the vividness of food-related mental imagery that participants were instructed to create and the intensity of participants’ self-reported food craving.

Clinical Implications of EI Theory

EI theory of craving has potentially valuable implications for the treatment of substance abuse and dependence. To the extent that mental imagery plays a significant role in the production of craving, tasks that demand attention and working memory to produce and maintain mental images may reduce the intensity of craving (Kavanagh, Andrade, & May, 2004). Several investigations (Harvey et al., 2005; Panabokke et al., unpublished manuscript; Versland & Rosenberg, unpublished manuscript) provide support for this claim, demonstrating that food and nicotine craving were reduced by tasks that required the use of mental imagery, in particular visual imagery. Presumably these tasks interfered with elaboration processes. If tasks requiring mental imagery consistently demonstrate a reduction in craving, clinicians might teach clients to engage in mental imagery tasks (or other tasks requiring the use of attention and working memory resources) to reduce both craving and likelihood of relapse.

Another clinical implication of EI theory involves coping with factors that elicit intrusive thoughts about a substance (e.g., external cues, negative affect). For instance, clinicians might teach clients to predict and avoid people, places, or situations that might trigger intrusive thoughts about their desired substance. Clinicians might also assist clients in understanding the
impact of negative affect on craving and assist clients in developing adaptive techniques to manage negative affect and strategies to maintain a positive mood. Kavanagh et al. (2004) suggest that engaging in pleasurable activities that demand cognitive resources such as attention and working memory may be especially useful in interfering with elaborative processes because these activities would demand attention and working memory processes required for elaboration, in addition to enhancing positive mood.

**Summary and Basis for Current Study**

Several studies (Harvey et al., 2005; Kemps et al., 2004; May et al., 2004; Panabokke et al., unpublished manuscript; Taylor et al., 2000; Versland & Rosenberg, unpublished manuscript) have supported the EI premise that mental imagery is a key component of craving by demonstrating the role of mental imagery in the development and/or reduction of craving. Although two studies have demonstrated a positive correlation between craving and vividness of substance-related imagery (Harvey et al., 2005; Kemps et al., 2004), to our knowledge, there are no studies in the literature specifically manipulating vividness of substance imagery to assess its impact on craving for that particular substance. Furthermore, although several studies have demonstrated that engaging in unrelated visual imagery tasks (Harvey et al., 2005; Panabokke et al., unpublished manuscript; Versland & Rosenberg, unpublished manuscript) or visuospatial tasks (Kemps et al., 2004) reduce craving by interfering with substance-related visual imagery, to our knowledge, there are no studies in the literature manipulating complexity of an unrelated visual task to assess its impact on craving. Therefore, the current research was designed as a two-part study to examine the impact on craving of vividness of cigarette imagery and complexity of unrelated visual task in order to shed light on these aspects of EI theory.
**Study 1: Does manipulating vividness of smoking-related imagery impact craving?**

Study 1 was designed to test the comparative impact of increasingly vivid versus decreasingly vivid smoking-related mental imagery (versus no change in smoking-related imagery) on craving for cigarettes in regular smokers. In accordance with EI theory, we predicted that increasingly vivid smoking-related mental imagery would produce more intense craving for cigarettes than decreasingly vivid smoking-related mental imagery, because imagining a smoking-related scene becoming more and more clear or vivid mimics the process of elaboration, in which the outcome is enrichment of target-related thoughts and images. We predicted that imagining a smoking-related scene becoming less and less clear or vivid would not provoke the same degree of elaboration and would result in lower craving.

**Study 2: Does manipulating complexity of a visual task unrelated to the target substance decrease craving?**

Study 2 was designed to evaluate the comparative impact of a relatively simple versus relatively complex visual task (versus no-task control) on craving for cigarettes in regular smokers. In accordance with EI theory, we predicted that both versions of the visual task would reduce craving (both require attention and working memory) relative to the no task control, but the complex version would result in a greater reduction of craving due to its higher demand for cognitive resources, which would presumably interfere with the process of elaboration.
STUDY 1

Method

Participants

In the spring of 2006, we sent email advertisements about the current research to approximately 15,000 undergraduate students, made announcements to students in general psychology classrooms, and posted a notice of our research on a website that informed students of extra credit opportunities. Students were eligible to participate in the study if they had smoked approximately one pack of cigarettes a day for the past 6 months, agreed to abstain from smoking cigarettes 6 hours prior to the time they participated, obtained a baseline craving score of 3 or higher on both QSU-Brief Factors (if they were assigned to the DVSI condition), and obtained a baseline craving score of 5 or lower on both QSU-Brief Factors (if they were assigned to the IVSI condition). As compensation for their participation, participants were offered entrance into a lottery in which they had the opportunity to win 1 of 3 cash prizes: $100, $75, $50. Participants who were enrolled in general psychology courses also were given experimental credit.

The first approximately 80 students who responded to the aforementioned recruitment strategies were invited to participate in Study 1. Of these students, 53 presented to and completed Study 1 in its entirety during the spring of 2006. In the summer of 2006, we sent 5000 email advertisements to students enrolled in the first summer session to recruit additional participants to replace those who were ineligible due to their smoking history and/or baseline craving not meeting eligibility criteria. Approximately 15 participants responded to summer recruitment, 7 of whom presented to and completed the study in its entirety, yielding a total of 60 participants in Study 1.
Measures

Questionnaire of Smoking Urges-Brief. The 10-item version of the Questionnaire of Smoking Urges (QSU-Brief; Cox, Tiffany, & Christen, 2001) was used to assess participants’ experience of craving (see Appendix B, Item 1). The overall QSU-Brief has excellent internal consistency (Cronbach’s alpha=0.97; Cox et al., 2001), and completion of the QSU-Brief does not increase craving as measured by a single VAS item (Shadel, Niaura, & Abrams, 2001). Participants were instructed to rate each of the 10 items on a 7-point scale ranging from “strongly disagree” to “strongly agree.” In addition to calculating an overall craving score by summing across the 10 items, analyses of the item structure have demonstrated that the QSU-Brief may be divided into two Factors (Cox et al., 2001). Factor 1 is characterized by a strong desire and intention to smoke, with smoking perceived as rewarding (items 1, 3, 6, 7, and 10). Factor 2 is characterized by anticipation of relief from negative affect and an urgent desire to smoke and includes items 4, 5, 8, and 9. Item 2 did not load on either Factor 1 or Factor 2. We calculated Factor scores for each participant by averaging across the items in each subscale. Then, for both Factors, we calculated a change score by subtracting each participant’s baseline Factor score from his/her post-intervention Factor score. Negative change scores indicated a decrease in craving and positive change scores indicated an increase in craving.

Vividness survey. We designed the first four items of this self-report questionnaire to assess the vividness of participants’ smoking-related mental imagery (Appendix B, Item 2). Specifically, using a 6-point scale ranging from “not at all” to “extremely,” participants rated how “vivid,” “detailed,” “vague,” and “fuzzy” their smoking-related mental imagery was following completion of the visual imagery task. The fifth item on this questionnaire asked participants to report whether they imagined smoking a cigarette during the imagery exercise.
Because there were large correlations among the first 4 items of the Vividness survey (median $r = 0.76$) and high internal consistency (Cronbach alpha coefficient $= 0.92$), the mean of the first 4 items was used to create a composite Vividness score (items 3 and 4 were reverse scored). Higher scores indicated more vivid imagery during the intervention. Item 5 (asking participants whether they imagined smoking) was examined separately.

**Fagerström Test for Nicotine Dependence.** The FTND (Appendix B, Item 3; Heatherton, Kozlowski, Frecker, & Fagerström, 1991) is a 6-item self-report measure, which was used to assess participants’ level of dependence on nicotine. Overall scores were calculated by summing the scores across the items and may range from 0 to 10, with higher scores indicating a higher level of nicotine dependence. In a study of smokers diagnosed with PTSD, Buckley et al. (2005) found that the FTND had excellent test-retest reliability (coefficient of 0.82; average interval between the two measurements was 8.3 days) and correlated significantly with both biological and psychological measures of nicotine dependence. Vink, Willemsen, Beem, and Boomsma (2005) reported acceptable levels of internal consistency in a sample of non-psychiatric Dutch smokers (Cronbach’s alpha coefficients were obtained for male smokers, female smokers, male ex-smokers and female ex-smokers and ranged from 0.65 to 0.71).

**Demographic questionnaire.** A demographic questionnaire designed for this study was used to assess participant characteristics including age, gender, ethnicity, and smoking history (see Appendix B, Item 4).
Stimulus Materials

*Increasingly vivid smoking-related imagery.* The Increasingly Vivid Smoking-related Imagery (IVSI) instructions were presented via audiotape to participants assigned to the IVSI condition (Appendix B, Item 5). For 10 seconds, participants were instructed to look at a single photograph of cigarette paraphernalia (i.e., a pack of cigarettes, ashtray, and book of matches) lying on a desk in a home office. Participants were then asked to close their eyes and hold this image in their mind for 10 seconds. While continuing to keep their eyes closed, at approximately 10-second intervals, participants were instructed to imagine having moved one step closer to the desk containing the cigarettes and paraphernalia, such that the cigarette imagery became increasingly more vivid.

*Decreasingly vivid smoking-related imagery.* The Decreasingly Vivid Smoking-related Imagery (DVSI) instructions were presented via audiotape to participants assigned to the DVSI condition (Appendix B, Item 6). For 10 seconds, participants were instructed to look at the same photograph presented in the IVSI condition. Participants were instructed to close their eyes and visualize the photograph for 10 seconds. While continuing to keep their eyes closed, at approximately 10-second intervals, participants were instructed to imagine having moved one step away from the desk containing the cigarettes and paraphernalia, such that the cigarette imagery became increasingly less vivid.

*No change in smoking-related imagery.* Participants assigned to the No Change in Smoking-related Imagery (NCSI) condition also received instructions via audiotape (Appendix B, Item 7). For 10 seconds, participants were instructed to look at the same photograph presented in the IVSI and DVSI conditions. Participants were instructed to close their eyes and visualize the photograph for 10 seconds. While continuing to keep their eyes closed, at
approximately 10-second intervals, participants were instructed to continue imagining the picture exactly as they had seen it in the picture.

**Procedure**

Testing sessions were conducted individually with each participant and lasted approximately 30 minutes. Because participants were instructed to abstain from smoking prior to their scheduled appointment, sessions were scheduled in the morning to maximize compliance and minimize discomfort from abstaining during waking hours.

Upon arrival to the testing session, eligibility was re-assessed and informed consent was obtained. Then the participant was randomly assigned to one of three smoking-related imagery conditions (i.e., IVSI, DVSI, or NCSI).

Immediately following assignment to condition, baseline craving was measured using the QSU-Brief, and the relevant audiotape was played based on the participant’s assigned smoking-related imagery condition. Following completion of the assigned smoking-related imagery task, participants were instructed by the primary researcher to complete the QSU-Brief for a second time, a self-report survey assessing imagery vividness, the FTND, and a demographic survey. To reduce craving resulting from the experimental manipulation, participants then listened to approximately 3 minutes of audio-taped beach-scene imagery unrelated to smoking (Appendix B, Item 8). Craving was reassessed to determine if additional beach imagery was warranted to reduce craving to baseline levels. Once craving was back to baseline levels, participants were debriefed. (See Appendix B, Item 9 for outline of Study 1 procedure.)
Results

Participant Characteristics

Sixty participants completed Study 1, of whom 21 were excluded from further data analysis. Six of the 60 participants were excluded because they did not meet eligibility based on their written responses to background questions in which they indicated smoking 10 or fewer cigarettes a day, smoking fewer than 6 days per week in the last 6 months, and/or for not having smoked for at least 3 months. To avoid a floor effect, an additional 11 participants were excluded because they were randomly assigned to the DVSI condition but scored 2 or less on at least one of the two QSU-Brief Factor scores at baseline. To avoid a ceiling effect, four of the 60 participants were excluded because they were randomly assigned to the IVSI condition but scored 6 or higher on at least one of the two QSU-Brief Factor scores at baseline.

The remaining 39 participants who met eligibility requirements included 21 females and 18 males, all but three of whom identified as White/European; one self-identified as Hispanic/Latino, one self-identified as Native American/Aleutian, and one self-identified as “Other.” Twenty-nine were between the ages of 18 and 22; seven were 23 to 27 years old; and three were 44 to 50 years old.

On average, participants first started smoking at 15 years of age. In regard to current smoking behavior (during the past 6 months), 31 participants smoked one pack of cigarettes per day, six participants smoked less than one pack per day, and two smoked more than one pack but less than two packs per day. Thirteen participants had been smoking at least one pack per day for 3 months to 1 year, nine had been smoking at least one pack per day for 1 to 3 years, and the remaining 17 had been smoking at least one pack per day for 3 or more years. Twenty-two
participants reported typically smoking with friends, 16 reported typically smoking alone, and one reported typically smoking with family.

The FTND indicated that the average participant’s level of dependence on nicotine was low (M = 4.05, SD = 1.56), but close to half the participants (n = 19) felt their smoking was either somewhat or completely out of their control, and all but two reported that going without cigarettes in the next month would be somewhat or very difficult. On average, participants had attempted to quit smoking on three prior occasions. Close to one-third (n = 12) reported having attempted to quit on 4 or more occasions. Table 1 contains a full listing of background characteristics for the sample.

Did Manipulating Vividness of Imagery Impact Craving?

According to EI theory, relative to craving with less vivid sensory images, craving with more vivid sensory images will be rated as stronger in intensity. To test this first hypothesis, that manipulating vividness of smoking-related imagery would impact craving for nicotine, we conducted a one-way between-groups analysis of variance on each of the QSU-Brief Factor change scores. There was a statistically significant difference in QSU-Brief Factor 1 change scores (strong desire/intention/smoking as rewarding) as a function of vividness condition [F(2, 36) = 4.82, p = .01]. The effect size, represented as partial eta squared, was .21. Post-hoc comparisons using the Least Significant Difference Test indicated that the mean for the IVSI condition (M = 0.85, SD = 1.13) was significantly different from the DVSI condition (M = -0.26, SD = 0.49) and the NCSI condition (M = -0.16, SD = 1.17). The NCSI condition did not differ significantly from the DVSI condition. In other words, imagining smoking paraphernalia becoming increasingly vivid resulted in a significant increase in Factor 1 craving from baseline
relative to imagining the paraphernalia becoming less vivid or imagining no change in smoking-related imagery. Table 2 contains the means for both dependent variables in Study 1.

Factor 2 change scores (urgent desire/relief smoking) did not differ significantly as a function of vividness condition \[F(2, 36) = 2.95, p = .065\], and the effect size, represented as partial eta squared, was .14. Post-hoc comparisons using the Least Significant Difference Test indicated that the mean Factor 2 change score for the IVSI condition (\(M = 0.63, SD = 0.77\)) was significantly different from the DVSI condition (\(M = -0.35, SD = 0.70\)), but the NCSI condition (\(M = 0.11, SD = 1.35\)) did not differ significantly from either of the other two experimental conditions. In other words, although the overall effect was not significant, follow-up \(t\)-tests revealed that imagining the paraphernalia becoming increasingly vivid resulted in a significant increase in Factor 2 craving relative to imagining the paraphernalia becoming less vivid (which resulted in a decrease in craving).

As another way to assess the relationship between vividness and craving, we calculated Pearson product-moment correlation coefficients between Vividness composite scores and QSU-Brief Factor change scores, combining participants in all three conditions. There was a positive and significant, but only moderate, correlation between craving and vividness of smoking-related imagery \([r(39) = .32, p = .047]\), with higher levels of vividness associated with higher levels of craving on QSU-Brief Factor 1 (strong desire/intention/smoking as rewarding). However, craving as measured by QSU-Brief Factor 2 (urgent desire/relief from negative affect) was not significantly correlated with Vividness scores.

We did not initially conceive of item 5 of the Vividness survey as a dependent variable (asking participants to report – yes or no – whether they imagined smoking a cigarette during the imagery exercise). Upon further consideration, we decided that item 5 was a proxy measure of
craving because imagining smoking during the imagery exercise, despite explicit instructions not to do so, reflected another aspect of craving not directly assessed by the QSU-Brief. Specifically, we conceptualize item 5 as a behavioral measure of craving (i.e., participants imagined smoking when instructed not to), whereas the QSU-Brief factors are subjective measures of craving (measuring participants’ desire and intention to smoke and their perceptions of smoking outcomes).

Therefore, we conducted a 2 (yes/no) x 3 (IVSI, DVSI, NCSI) chi-square test to examine whether responses to item 5 were associated with condition. Results demonstrated a significant association \[ \chi^2(2) = 6.84, p = .033 \]. Specifically, none of the 13 participants in the DVSI condition reported having imagined smoking during the imagery script, whereas 36% (5 of 14 participants) in the NCSI condition and 42% (5 of 12 participants) in the IVSI condition reported having imagined smoking. To the extent that having imagined smoking during the imagery script is a measure of craving, participants in the NCSI and IVSI conditions more often experienced this aspect of craving than participants in the DVSI condition.

Collectively, these findings suggest a positive relationship between vividness of smoking-related imagery and craving, and also partially support the hypothesis based on EI theory that manipulating vividness of substance-related imagery should impact craving for that substance. The support is only partial because vividness had a variable impact on craving, significantly impacting QSU-Brief Factor 1 (strong desire/intention/smoking as rewarding), but having no significant impact on QSU-Brief Factor 2 (urgent desire/relief smoking).

As an exploratory analysis, we examined whether reported craving following exposure to assigned condition (DVSI, IVSI or NCSI) differed by gender. Within each condition, we conducted two independent-samples t-tests to compare craving for males and females on each of
the QSU-Brief Factor change scores. There were no significant gender differences in QSU-Brief Factor 1 or Factor 2 change scores in any of the three conditions (all t values ≤ 2.07; all p values ≥ .065). Within each of the three conditions (DVSI, IVSI and NCSI), we also conducted a 2 (yes/no) x 2 (males/females) chi-square test to examine whether responses to item 5 of the Vividness survey (asking participants to report – yes or no – whether they imagined smoking a cigarette during the imagery exercise) were associated with gender. Results demonstrated a significant association only in the IVSI condition [Φ = -0.66, p = .033]. Specifically, after imagining smoking paraphernalia becoming increasingly vivid, four of five male participants reported having imagined smoking a cigarette, whereas six of seven female participants denied having imagined smoking a cigarette. Collectively, these findings suggest minimal gender differences in craving experienced following exposure to assigned condition (DVSI, IVSI or NCSI).

*Manipulation Check: What is the Impact of Imagery Condition on Vividness?*

According to EI theory, differences in vividness of smoking-related imagery should account for the differences in craving experienced by participants. As a manipulation check, we conducted a one-way between-groups analysis of variance to assess whether vividness of smoking-related imagery differed across the three experimental conditions (IVSI, DVSI, NCSI). The test revealed a statistically significant difference [F(2, 36) = 6.49, p = .004], and the effect size, represented as partial eta squared, was .27 (see Table 2 for means by condition). Post-hoc comparisons using the Least Significant Difference test indicated that the mean Vividness score for the DVSI condition (M = 2.94, SD = 1.23) was significantly different from both the IVSI condition (M = 4.67, SD = 1.19) and the NCSI condition (M = 4.34, SD = 1.40). The IVSI condition did not differ significantly from the NCSI group. In other words, participants who
imagined smoking paraphernalia becoming less vivid, subsequently reported significantly less vivid imagery relative to those who imagined no change in smoking-related imagery or smoking paraphernalia becoming increasingly vivid.

Is Level of Nicotine Dependence Related to Craving and Vividness of Smoking-Related Imagery?

It is possible that the greater one’s dependence on nicotine, the more intense one’s experience of craving and/or the more vivid one’s imagery of smoking paraphernalia. Therefore, we also were curious if severity of nicotine dependence was related to either an individual’s experience of craving or vividness of smoking-related imagery, regardless of assigned condition. As an exploratory analysis, within each condition (IVSI, DVSI, NCSI), we calculated Pearson product-moment correlation coefficients to examine the correlation of nicotine dependence with craving and vividness of smoking-related imagery. Level of nicotine dependence was not significantly correlated with craving scores or vividness of smoking-related imagery for any of the three conditions. This may not be a sensitive test of the relationship, however, given the lack of variability in the sample’s level of dependence (out of 10 points, 82% of participants scored less than a 6 on the FTND).
STUDY 2

Method

Participants

The eligibility requirements for Study 2 were similar to those of Study 1. Specifically, students were eligible to participate in the study if they had smoked approximately one pack of cigarettes a day for the past 6 months, agreed to abstain from smoking cigarettes 6 hours prior to the time they participated, and obtained a post-cue exposure craving score of 4 or higher on at least one QSU-Brief Factor.

The 53 participants who completed Study 1 during the spring semester of 2006 were provided a description of the purpose of Study 2 (i.e., to evaluate craving in smokers) and informed that their participation on a separate occasion would allow them to be entered into a second lottery in which they had the opportunity to win 1 of 3 cash prizes: $100, $75, $50. (Students enrolled in general psychology courses were told that they also would be given experimental credit.) Twenty-eight of the 53 participants who completed Study 1 decided to participate in Study 2 and completed Study 2 in its entirety. An additional 17 students who contacted the researchers after completion of Study 1 data collection in the spring of 2006 completed Study 2, yielding a total of 45 participants.

Measures

Questionnaire of Smoking Urges-Brief. See page 17 of the Study 1 Method Section for a detailed description of this measure. As in Study 1, we calculated Factor scores for each participant by averaging across the items in each subscale. Then, for both Factors, we calculated a change score by subtracting each participant’s post-cue exposure Factor score from his/her
post-intervention Factor score. Negative change scores indicated a decrease in craving and positive change scores indicated an increase in craving.

**Vividness survey.** With the exception of item 5 (asking participants whether they imagined smoking), which was excluded from this self-report questionnaire in Study 2, this measure was identical to that used in Study 1. See page 17 of the Study 1 Method Section for a description of this measure. This scale demonstrated high internal consistency post-cue exposure (Cronbach alpha coefficient = 0.73) and post-intervention (Cronbach alpha coefficient = 0.91). Furthermore, we found medium to large correlations among most of the items on this survey post-cue exposure (median r = 0.40) and post-intervention (median r = 0.77). Therefore, a composite Vividness score was obtained for each participant (post-cue exposure and post-intervention) by calculating the average score across the four items (items 3 and 4 were reverse scored). Higher scores indicated more vivid imagery. Then we calculated a change score by subtracting each participant’s post-cue exposure Vividness score from his/her post-intervention Vividness score. Negative change scores indicated a decrease in vividness of smoking-related imagery and positive change scores indicated an increase in vividness.

**Effort survey.** This questionnaire (Appendix B, Item 10) comprised 7 questions designed to assess how much effort participants put into various aspects of the visual task designed to disrupt elaboration (e.g., watching, memorizing, and identifying symbols displayed on a computer screen during the visual task). Participants in the simple and complex visual task conditions were instructed to rate each item on a 10-point scale ranging from “no effort at all” to “intense amount of effort.” Only 7 of 21 coefficients across the 7 items were at least modest in size and statistically significant (median r across 21 correlations = 0.34). However, due to the scale’s high internal consistency (Cronbach alpha coefficient = 0.73), and for ease of analysis,
we calculated a composite Effort score for each participant by averaging across the 7 items. Higher scores indicated a greater amount of effort was exerted during the visual task designed to disrupt elaboration.

*Retrospective VAS Rating of Craving survey.* We designed the Retrospective VAS Rating of Craving (Retro-VAS-Craving) survey, a 3-item self-report questionnaire (Appendix B, Item 11), to assess participants’ experience of craving during the visual task designed to disrupt elaboration (as well as during the no-task-control time period). Specifically, participants were instructed to think back to when they were watching the computer screen during the visual task (or “taking a break and resting their hands” for those assigned to a No Visual Task control condition) and rate how much they “craved,” “needed,” and “desired” a cigarette at that time on a 100-point scale ranging from “the least amount of craving ever experienced” to “the highest amount of craving ever experienced.” This measure of craving was different from the QSU-Brief, which was a concurrent self-report questionnaire instructing participants to answer questions about their experience of craving “now” (i.e., at the time of survey completion pre-cue exposure, post-cue exposure, and post-intervention). Due to high internal consistency (Cronbach alpha coefficient = 0.91) and large correlations among the three items on this survey (median r = 0.78), a composite Retro-VAS-Craving score was obtained for each participant by creating an average score across the three items. Higher scores indicated higher self-reported craving during the post-cue exposure task.

*Fagerström Test for Nicotine Dependence.* See page 18 of the Study 1 Method Section for a description of this measure.

*Demographic questionnaire.* See page 18 of the Study 1 Method Section for a description of this measure.
Stimulus Materials

Simple visual task. Participants assigned to the simple visual task (SVT) were instructed to watch a computer screen for approximately 30 seconds during which a grouping of 6 relatively large symbols moved repetitively back and forth across the center of the screen at a relatively slow pace (see Appendix B, Item 12 for detailed information on size and speed).

Complex visual task. Participants assigned to the Complex Visual Task (CVT) were also exposed to a grouping of symbols on a computer screen for 30 seconds. However, the grouping consisted of 10 symbols (versus 6) and spun around while moving across the center of the screen. Furthermore, the symbols used in the CVT were smaller in size and moved across the screen at a faster pace (relative to those in the SVT; see Appendix B, Item 13 for detailed information on size and speed).

No visual task. Participants assigned to the No Visual Task (NVT) control condition were instructed to “take a break and rest their hands” while the researcher cleaned up the cue exposure room. This “break” lasted 1 minute for each participant assigned to the NVT condition, and was designed to match the period of time it took the primary researcher to provide SVT and CVT participants with their task instructions and a 30-second exposure to the computer task.

Procedure

Upon arrival to the testing session, eligibility was re-assessed and informed consent was obtained. Then the participant was randomly assigned to one of three conditions (i.e., SVT, CVT, or NVT). Immediately following assignment to condition, the participant’s baseline craving was measured using the QSU-Brief and his/her vividness of cigarette imagery was assessed using the Vividness survey. The participant was then instructed to follow the primary
researcher into a neighboring room where audio-taped instructions guided the participants to attend to the sight, smell, and feel of an unlit and lit cigarette for approximately 1 minute (Appendix B, Item 14). The participant and researcher (carrying cue exposure materials) then returned to the original testing room. The smoking paraphernalia was placed on a table beside the desk used by the participant when completing all remaining surveys and study tasks (i.e., SVT, CVT, or NVT). This was designed to reduce the likelihood that any decreases in craving following the ensuing visual task would be attributed to removal of smoking-related stimuli.

After returning to the original testing room, the participant completed a second QSU-Brief and Vividness survey. Then, the participant was exposed to one of three conditions (i.e., SVT, CVT, or NVT) depending on his/her assigned condition. Participants assigned to the SVT or CVT condition were provided a brief description of their assigned task by the primary researcher (i.e., “During this task, you will see a group of symbols float across the computer screen”). They were then instructed, “Do your best to focus on the visual task because you will be asked to identify these symbols from a larger group of symbols shortly after task completion.” Although the visual display lasted 30 seconds for both SVT and CVT participants, these instructions were provided to reduce the likelihood that participants would vary in regard to time spent engaging in the visual task as a function of condition.

Following exposure to the CVT, SVT, or NVT, participants were instructed by the primary researcher to complete a third QSU-Brief and Vividness survey. Then CVT and SVT participants completed the Effort survey and were asked to identify, from a list of symbols, those symbols they saw during the visual task (see Appendix B, Item 15 for SVT symbol-identification task and Appendix B, Item 16 for CVT symbol-identification task). NVT participants did not complete the Effort survey, but they were presented with a large group of
symbols and asked to identify symbols that were most interesting or appealing (Appendix B, Item 16). This task was designed to resemble the symbol identification task required of the CVT and SVT participants.

In addition, all participants completed the Retro-VAS-Craving to determine the level of craving they experienced during the computer task (CVT and SVT participants) or during the no-task-control time period when they were “taking a break and resting their hands” (NVT participants). Finally, each participant completed the FTND and a demographic survey.

To reduce any remaining craving resulting from the experimental manipulation, participants then listened to approximately 3 minutes of audio-taped park/playground imagery unrelated to smoking (Appendix B, Item 17). Craving was reassessed to determine if additional park imagery was warranted to reduce craving to baseline levels. Once craving had returned to baseline levels, participants were debriefed and provided experimental credit and/or entered into a participant lottery. (See Appendix B, Item 18 for outline of Study 2 procedure.)

Results

Participant Characteristics

Forty-five participants completed Study 2, of whom six were excluded from further data analysis. Data from three of the 45 participants were excluded because those participants did not meet eligibility based on their written responses to background questions in which they indicated smoking 10 or fewer cigarettes a day, smoking fewer than 5 days per week in the last 6 months, and/or for not having smoked for at least 3 months. To avoid a floor effect, data from an additional three participants were excluded because those participants had not scored a 4 or higher on at least one of the two QSU-Brief Factors after cue exposure.
The remaining 39 participants who met eligibility requirements included 19 females and 20 males, all but four of whom identified as White/European; one self-identified as Black/African American, one self-identified as Hispanic/Latino, and two self-identified as “Other.” Thirty-four were between the ages of 18 and 23; four were 24 to 26 years old; and one was 47 years old.

On average, participants first started smoking at 16 years of age. In regard to current smoking behavior (during the past 6 months), 29 participants smoked one pack of cigarettes per day, six smoked more than one pack but less than two packs per day, and four smoked less than one pack of cigarettes per day. Sixteen participants had been smoking at least one pack of cigarettes a day for 3 months to 1 year, thirteen had been smoking at least one pack a day for 1 to 3 years, and the remaining 10 had been smoking at least one pack a day for 3 or more years. Thirty participants reported typically smoking with friends and nine reported typically smoking alone.

The FTND indicated that the average participant’s level of dependence on nicotine was low (M = 3.95, SD = 1.50), but 20 participants reported that their cigarette use was only somewhat under their control and close to half of the participants (n = 18) reported their smoking was either somewhat or completely out of their control. All but one participant reported that going without cigarettes in the next month would be somewhat difficult (n = 14) or very difficult (n = 24). On average, participants had attempted to quit smoking on 4 prior occasions. Ten of the 39 participants reported attempting to quit on 5 or more occasions. Table 3 contains a full list of the background characteristics for the sample participating in Study 2.
Did Manipulating Complexity of an Unrelated Visual Task Impact Craving?

According to EI theory, engaging in the visual task would result in a decrease in craving because the task requires use of limited cognitive resources (such as visual attention and working memory) necessary for elaboration resulting in craving. Furthermore, relative to a simple visual task, a complex visual task should require a greater amount of limited cognitive resources, resulting in larger decreases in craving. To test this second hypothesis, that manipulating complexity of a visual task unrelated to smoking would impact craving, we conducted one-way between groups ANOVAs on both the two QSU-Brief Factor change scores and Retro-VAS-Craving.

There was a statistically significant difference as a function of condition only when craving was measured using the Retro-VAS-Craving \[ F(2, 36) = 4.55, p = .017 \]. The effect size, represented as partial eta squared, was .20 (see Table 4 for means by condition). Post-hoc comparisons using the Least Significant Difference test indicated that the mean score for the NVT condition (M = 73.51, SD = 11.89) was significantly different from both the SVT condition (M = 51.73, SD = 26.07) and CVT condition (M = 49.49, SD = 26.23), but the latter two visual task conditions did not differ significantly from each other. In other words, participants who were exposed to either a simple or complex version of a visual task following cue exposure reported experiencing significantly less craving during the intervention than control-group participants who did not participate in a visual task.

As another way to assess the relationship between perceived complexity and craving, we calculated Pearson product-moment correlation coefficients between the Effort survey and craving measures combining participants in all three conditions. Neither the QSU-Brief Factor change scores nor Retro-VAS-Craving were significantly correlated with the Effort composite
score (degree of effort devoted to various aspects of the visual task, such as watching, identifying, and memorizing symbols on the computer screen). This may not be a sensitive test of the relationship, however, given the lack of variability in the sample’s Effort scores (out of a total of 10 points, 100% of participants scored above a 6 on the Effort survey).

Collectively, these findings provide partial support for the hypothesis based on EI theory that engaging in a visual task that requires attention and working memory will impact craving for that substance. Specifically, engaging in either a simple or complex visual task equally impacted Retro-VAS-Craving during the intervention, but such tasks did not impact concurrent reports of craving experienced immediately following completion of the intervention.

As an exploratory analysis, we examined whether self-reported craving experienced during or immediately following the visual task intervention (SVT, CVT or NVT) differed by gender. For each intervention, we conducted three independent-samples t-tests to compare craving for males and females on the two QSU-Brief Factor change scores and the Retro-VAS-Craving. There was a significant gender difference only for the Retro-VAS-Craving measure for participants in the complex intervention \( t(11) = 3.69, p = .004 \). Specifically, female participants \( M = 69.72, SD = 17.53 \) experienced significantly more craving during the complex intervention relative to male participants \( M = 32.14, SD = 18.97 \). There were no significant gender differences in QSU-Brief Factor 1 or Factor 2 change scores following any of the three interventions (all \( t \) values \( \leq 1.96 \); all \( p \) values \( \geq .076 \)). Collectively, these findings suggest no pattern of gender differences in craving experienced during or immediately following the visual task intervention or no task control.
Manipulation Check: What is the Impact of Visual Task Condition on Vividness?

According to EI theory, differences in vividness of smoking-related imagery should account for the significant difference in craving experienced by participants who engaged in a visual task unrelated to smoking versus those in the control condition instructed to “take a break.” Therefore, as a manipulation check, we conducted a one-way between-groups analysis of variance examining the degree to which vividness of smoking-related imagery changed from post-cue exposure to post-intervention across the three conditions (SVT, CVT, and NVT). There was a marginally significant difference in Vividness change scores \( F(2, 36) = 3.24, p = .051 \), and the effect size, represented as partial eta squared, was .15 (see Table 4 for means by condition). Post-hoc comparisons using the Least Significant Difference test indicated that the mean score for the CVT condition (\( M = -1.33, SD = 1.04 \)) was significantly different from the NVT condition (\( M = -0.40, SD = 0.96 \)), but not from the SVT condition (\( M = -0.90, SD = 0.75 \)). The SVT and NVT conditions did not differ significantly in the Vividness change score. In other words, engaging in a complex visual task resulted in the greatest decrease in vividness of smoking-related imagery from pre-intervention. This decrease was significantly different from the decrease in vividness which occurred naturally with time in the control condition, but it was not significantly different from the decrease in vividness that occurred after engaging in the simple visual task.

As an additional manipulation check, we also examined the relationship between vividness of smoking-related imagery (as measured by the Vividness change score) and the three measures of craving (the QSU-Brief Factor change scores, Retro-VAS-Craving) using Pearson product-moment correlations coefficient. There were positive and significant correlations between changes in all three craving scales and changes in vividness of smoking-related
imagery, with greater decreases in vividness associated with greater decreases in craving.

Specifically, there was a strong, positive correlation between the Vividness change score and QSU-Brief Factor 1 (strong desire/intention/smoking as rewarding; r(39) = .65, p = .000); and there were moderate, positive correlations between vividness and QSU-Brief Factor 2 (urgent desire/relief smoking; r(39) = .44, p = .005) and Retro-VAS-Craving [r(39) = .48, p = .002]. 

Consistent with EI theory, as vividness of smoking-related imagery increased, all three measures of craving increased.

Finally, we hypothesized that relative to engaging in a complex visual task following cue exposure, engaging in a simple visual task would require fewer limited cognitive resources necessary for elaboration, resulting in smaller decreases in craving. As a second type of manipulation check, we conducted an independent-samples t-test to compare the degree of cognitive effort participants in the SVT versus CVT conditions reported devoting to various aspects of the visual task designed to disrupt elaboration. As examination of Table 4 reveals, there was no significant difference in Effort scores for participants assigned to the SVT (M = 8.47, SD = 1.03) and those assigned to the CVT ([M = 8.27, SD = 0.61; t(19) = 0.56, p = .56]. This finding may partially explain why there was no significant difference in craving (as measured by the QSU-Brief Factor scores or Retro-VAS-Craving) between the SVT and CVT conditions.

Is Level of Nicotine Dependence Related to Experience of Craving and Experience of Visual Task?

It is possible that the greater one’s dependence on nicotine, the more intense one’s experience of craving and/or the more difficult it is to devote attention to an unrelated visual task following cue exposure. Therefore, we also were curious if severity of nicotine dependence was
related to either an individual’s experience of craving or level of effort devoted to completion of the task, regardless of assigned condition. As an exploratory analysis, we calculated the correlation of nicotine dependence with ratings of craving and of effort devoted to the visual task. Level of nicotine dependence was not significantly correlated with craving (as measured by the QSU-Brief factor scores and Retro-VAS-Craving) or Effort scores. This may not be a sensitive test of the relationship, however, given the lack of variability in the sample’s level of nicotine dependence (out of 10 points, 87% of participants scored less than a 6 on the FTND).
DISCUSSION

The current research examined two predictions based on EI theory. In Study 1, 39 college students who smoked at least 11-20 cigarettes/day for the past 3-6 months were assigned to imagine smoking-related imagery becoming either more vivid or less vivid (versus no-change control) to examine the impact of experimentally manipulating vividness of imagery on self-reported craving for nicotine using the QSU-Brief. Manipulating vividness of substance-related imagery had a significant impact on craving measured by QSU-Brief Factor 1 (strong desire/intention/smoking as rewarding), but had no significant impact on craving measured by QSU-Brief Factor 2 (urgent desire/relief smoking). In addition, there was a positive relationship between vividness of imagery and whether participants imagined smoking during the imagery intervention and Factor 1 craving change scores.

In Study 2, 39 college students who smoked at least 11-20 cigarettes/day for the past 3-6 months underwent cue exposure and were then instructed to attend to a relatively-simple versus relatively-complex visual task (versus a no-visual-task control) to examine the impact of complexity of a task unrelated to smoking on the QSU-Brief and the average of three VAS items measuring craving. Engaging in either the simple or complex visual task significantly and equally impacted craving during the intervention (Retro-VAS-Craving), but did not significantly impact concurrent reports of craving on the QSU-Brief following completion of the intervention.

Similar to previous research (Harvey et al. 2005; Kemps et al., 2004; May et al., 2004, Taylor et al., 2000), Study 1 supported the EI-based premise that imagery plays an important role in the experience of craving. Study 1 also demonstrated a significant positive correlation between vividness of imagery and craving in regular smokers (replicating previous findings demonstrated in food dieters; Harvey et al., 2005; Kemps et al., 2004), and partially supported
the hypothesis based on EI theory that manipulating vividness of substance-related imagery should impact craving for that substance. Imagining smoking-related imagery becoming more vivid produced significantly more intense craving on QSU-Brief Factor 1 (strong desire/intention/smoking as rewarding) – but not on QSU-Brief Factor 2 (urgent desire/relief smoking) – than imagining no change in vividness or smoking-related imagery becoming less vivid.

Furthermore, the results are consistent with the EI assumption that these changes in craving subsequent to the imagery intervention were the outcome of changes in vividness of smoking-related imagery because there was a statistically significant difference in Vividness scores for the three conditions in the expected direction. Specifically, participants asked to imagine decreasingly vivid smoking-related imagery subsequently reported significantly less vivid imagery relative to those participants asked to imagine increasingly vivid smoking-related imagery and no change in imagery.

Similar to previous research (Harvey et al., 2005; Kemps et al., 2004; Panabokke et al., unpublished manuscript; Versland & Rosenberg, unpublished manuscript), Study 2 supported, but only partially, EI theory’s proposal that cognitive interventions (especially those that interfere with visual imagery of a target substance) will reduce craving. Relative to participants in a control condition who were instructed to “take a break” following cue exposure, those who participated in either a relatively simple or relatively complex visual task unrelated to smoking reported experiencing significantly less craving during the intervention (as indicated by the Retro-VAS-Craving). This occurred despite participants having completed the visual task and craving surveys in close proximity to the smoking paraphernalia used during cue exposure (i.e., smoking paraphernalia was placed on a table directly beside the desk participants sat at to complete the visual task and surveys).
These consistencies with previous research notwithstanding, several results from Study 1 and Study 2 were contrary to our hypotheses. In Study 1, contrary to our prediction, imagining no change in smoking-related imagery did not result in significantly higher craving than the decreasing vividness condition. Unlike the DVSI script, the NCSI script did not use the words “cigarette,” “matches,” and “ashtray” following removal of the stimulus picture. The DVSI script used the aforementioned trigger words at two separate time periods to instruct participants to imagine those images becoming less clear or less vivid. Mention of these trigger words may have restored the associated images in the participants’ minds, which in turn would compete with our instruction to decrease the vividness of these images. Future research might control for the number of times participants are exposed to trigger words during guided imagery or alternative interventions that manipulate vividness of imagery.

Two findings from Study 2 also appeared inconsistent with EI theory. Firstly, contrary to our hypothesis, complexity of the visual task did not have a significant impact on craving. This finding may have occurred, in part, because participants did not perceive the SVT task to be more complex or difficult than the CVT task. Although we constructed the tasks so that the CVT grouping of symbols was greater in number, smaller in font size, more complex in regard to rotation style, and faster in rotation speed, we did not specifically examine differences in perceived task difficulty. We did, however, examine the degree of effort participants reported having devoted to various aspect of the visual task and found no difference between the SVT and CVT conditions. This finding is consistent with the idea that participants may not have perceived these tasks to vary in regard to task difficulty.

In addition, because participants were told they would be asked to identify the symbols displayed in the visual task interventions, even those in the simple condition may have devoted
more cognitive resources than necessary for completion of the simple visual task, resulting in similar levels of retrospective craving on the VAS items. Finally, both the simple and complex visual task lasted only 30 seconds. It is possible that craving will decrease only with longer exposure to this type of visual task.

The second unexpected finding in Study 2 was that the visual task significantly impacted the degree to which participants “craved,” “needed,” and “desired” cigarettes during the intervention, but did not significantly impact scores on the QSU-Brief, which was administered after the task ended. This finding is inconsistent with previous research which demonstrated that visual imagery or visuospatial tasks significantly decreased craving for both food and nicotine (Harvey et al., 2005; Kemps et al., 2004; Panabokke et al., unpublished manuscript; Versland & Rosenberg, unpublished manuscript).

Firstly, with the exception of Kemps et al. (2004), the interventions employed in previous research (Harvey et al., 2005; Panabokke et al., unpublished manuscript; Versland & Rosenberg, unpublished manuscript) were at least 2 minutes in duration, whereas both versions of the visual task intervention employed in the current research were only 30 seconds in duration. Although we recognized this potential limitation of a relatively short intervention, we chose a 30 second visual task because we were concerned about the reduction of craving that naturally occurs with time, and equally concerned about participants spending an equal amount of time engaging in their assigned task (it is possible that after 30 seconds of the intervention, participants in the simple condition would have discontinued engaging in the task out of boredom). Future research might examine the impact of duration of task on craving.

Secondly, unlike participants in the current Study 2, participants in previous research (with the exception of Kemps et al.) were not exposed to smoking paraphernalia following
completion of subsequent craving surveys. Craving may not have differed as a function of condition immediately after the visual task in the current Study 2 because, following completion of the intervention, participants were re-exposed to external smoking cues from which the task distracted them temporarily. In addition, we employed different post-intervention craving measures in the current Study 2 (QSU-Brief Factor 1 and 2) than were used in previous research (e.g., full scale QSU-Brief; unspecified food craving surveys).

It is also possible that visual imagery or visuospatial tasks employed in previous research were more demanding of cognitive resources than the visual task employed in the current Study 2. Although it is difficult to determine differences in complexity of interventions across studies, it is notable that an eye movement task employed by Kemps et al. (2004), in which participants simply watched a box move around a computer screen, resulted in significantly less post-intervention craving relative to a control condition. Presumably, both versions of the visual task employed in the current Study 2 are at least as complex as the aforementioned eye movement task.

In addition to some of the issues raised above, the current Study 1 and Study 2 have several limitations. We conducted this research with a college student sample largely due to ease of recruitment. The results found in our studies might not generalize from younger, less experienced smokers to community samples with longer smoking histories and more severe dependence on nicotine. However, our participants were appropriate candidates on which to test craving interventions. Participants across the two studies were regular smokers; most reported that abstinence in the next month would be somewhat or very difficult; close to half reported smoking being somewhat or completely out of their control; and most reported multiple attempts at quitting.
A second potential limitation is that we used self-report instruments to measure craving (QSU-Brief; Item 5 of the Vividness survey; VAS items). Self-report instruments are an indirect measure of participants’ subjective experience of craving and are subject to demand characteristics. Although we could have employed other measures considered indicative of craving (e.g., autonomic physiological activity or behavioral responses), these too assess only correlates of the phenomenon. A non-verbal assessment of the subjective experience of craving does not currently exist.

Furthermore, experimenter characteristics (verbal and non-verbal behavior, voice quality, and/or physical appearance) could have influenced participants’ reactions to imagery interventions. Except for several participants in Study 1 who were run by a trained undergraduate research assistant, the primary researcher interacted with the vast majority of all remaining participants in both Study 1 and Study 2. To the degree that characteristics of the experimenters influenced response to the procedure, this may also limit generalizability of the results. However, in both Study 1 and Study 2, we employed an audio-tape of a male voice to control for voice quality and duration of the imagery intervention and cue exposure.

Another potential limitation of Study 1 is that we confounded vividness of smoking-related imagery with imagined proximity to, size of, and salience of smoking paraphernalia. Because we instructed participants to imagine walking toward or away from smoking paraphernalia such that the image of the paraphernalia became increasingly or decreasingly vivid, we not only manipulated vividness of smoking imagery, but also the size and salience of the smoking paraphernalia and the participant’s proximity to the smoking paraphernalia. Any one or more of these other factors could have influenced the changes in craving scores.
Limitations in Study 2 include using only one stimulus (white symbols floating across a black computer screen) in the visual task conditions. Use of different stimuli might have different effects on elaboration of smoking-related imagery and/or craving. Furthermore, informing participants in Study 2 that they would be asked to identify symbols upon completion of the visual task may have created anxiety in the SVT and CVT conditions. The experience of anxiety while performing some cognitive tasks has been associated with an increase in self-reported craving (Kavanagh, Andrade, & May, 2005), which would limit the apparent impact of the visual task itself.

In addition to the aforementioned limitations, although we measured craving immediately after Study 1 and 2 interventions, we did not measure craving at subsequent time intervals (e.g., 5, 10, 15 minutes post-intervention). It would have been interesting to examine whether differences in craving experienced immediately following the intervention persisted over time.

Despite these apparent limitations, this research has potentially valuable implications for the treatment of smokers who wish to reduce or quit smoking. Because Study 1 demonstrated the impact of guided scripts to increase and decrease craving for cigarettes, clinicians might teach smokers strategies to decrease the vividness of substance-related mental imagery (e.g., imagine yourself getting further and further away from the desired substance…such that you can’t see, smell, or taste it as clearly…until you notice you can’t see, smell, or taste the substance at all). Study 2 demonstrated the impact of the visual task on craving during the intervention suggesting that smokers may benefit from watching visual displays (e.g., Nintendo game-boy, cell phone games, I-Pod screen, desk top computer screen savers) when they are seeking immediate relief from cigarette craving. Given the apparent rebound in craving experienced following completion of the visual task, clinicians should review with smokers the impact of
external cues on craving and may wish to encourage smokers to leave situations in which they are exposed to external cues either before or while engaging in a preferred visual task (based on safety considerations).
REFERENCES


Table 1

*Demographic Characteristics of Study 1 Sample*

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>M(SD) or % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>23.15 (7.31)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>54% (21)</td>
</tr>
<tr>
<td>Male</td>
<td>46% (18)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
</tr>
<tr>
<td>White/European</td>
<td>92% (36)</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>3% (1)</td>
</tr>
<tr>
<td>Native American/Aleutian</td>
<td>3% (1)</td>
</tr>
<tr>
<td>Other</td>
<td>3% (1)</td>
</tr>
<tr>
<td>Age When First Smoked (years)</td>
<td>15.47 (1.94)</td>
</tr>
<tr>
<td>Dollars spent on cigarettes/week</td>
<td>25.60 (6.35)</td>
</tr>
<tr>
<td>How often smoke/week? (past 6 months)</td>
<td></td>
</tr>
<tr>
<td>7 days</td>
<td>95% (37)</td>
</tr>
<tr>
<td>6 days</td>
<td>5% (2)</td>
</tr>
<tr>
<td>How many packs/day? (past 6 months)</td>
<td></td>
</tr>
<tr>
<td>1 pack</td>
<td>79% (31)</td>
</tr>
<tr>
<td>Less than 1 pack</td>
<td>15% (6)</td>
</tr>
<tr>
<td>More than 1 but less than 2</td>
<td>5% (2)</td>
</tr>
<tr>
<td>How long smoked pack/day?</td>
<td></td>
</tr>
<tr>
<td>3 or more years</td>
<td>44% (17)</td>
</tr>
<tr>
<td>3 months-1 year</td>
<td>33% (13)</td>
</tr>
<tr>
<td>1-3 years</td>
<td>23% (9)</td>
</tr>
<tr>
<td>With whom do you typically smoke?</td>
<td></td>
</tr>
<tr>
<td>Friends</td>
<td>56% (22)</td>
</tr>
<tr>
<td>Alone</td>
<td>41% (16)</td>
</tr>
<tr>
<td>Family</td>
<td>3% (1)</td>
</tr>
</tbody>
</table>

Note. Table 1 continues on the subsequent page.
### Table 1 (contd.)

*Demographic Characteristics of Study 1 Sample*

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>M(SD) or % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree to which use under control?</td>
<td></td>
</tr>
<tr>
<td>Somewhat/completely under my control</td>
<td>51% (20)</td>
</tr>
<tr>
<td>Somewhat/completely out of my control</td>
<td>49% (19)</td>
</tr>
<tr>
<td>How easy/difficult to abstain in next month?</td>
<td></td>
</tr>
<tr>
<td>Somewhat/very difficult</td>
<td>95% (37)</td>
</tr>
<tr>
<td>Somewhat easy</td>
<td>5% (2)</td>
</tr>
<tr>
<td>Number of Quit Attempts</td>
<td></td>
</tr>
<tr>
<td>Less than 3</td>
<td>44% (17)</td>
</tr>
<tr>
<td>3-5</td>
<td>41% (16)</td>
</tr>
<tr>
<td>6 or more</td>
<td>15% (6)</td>
</tr>
<tr>
<td>Level of Dependence (FTND score)</td>
<td></td>
</tr>
<tr>
<td>Low (3-4)</td>
<td>51% (20)</td>
</tr>
<tr>
<td>Medium-High (5-7)</td>
<td>31% (12)</td>
</tr>
<tr>
<td>Very low (0-2)</td>
<td>15% (6)</td>
</tr>
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<td>Very high (8-10)</td>
<td>3% (1)</td>
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<tr>
<td>Hours abstained prior to participation</td>
<td></td>
</tr>
<tr>
<td>6-10 hours</td>
<td>61% (24)</td>
</tr>
<tr>
<td>More than 10</td>
<td>38% (15)</td>
</tr>
</tbody>
</table>

Note. For all items, n=39. Due to rounding, proportions may not equate to 100%.
Table 2

Mean and Standard Deviation Scores for Dependent Measures and Manipulation-Check Measure in Study 1

<table>
<thead>
<tr>
<th>Measures</th>
<th>Condition</th>
<th>DVSI</th>
<th>NCSI</th>
<th>IVSI</th>
<th>F(df)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QSU-Brief Factor 1</td>
<td>Change score</td>
<td>-0.26 (0.49)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.16 (1.17)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.85 (1.13)&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>4.82(2,36)&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>QSU-Brief Factor 2</td>
<td>Change score</td>
<td>-0.35 (0.70)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.11 (1.35)</td>
<td>0.63 (0.77)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.95(2,36)</td>
</tr>
<tr>
<td>Vividness score</td>
<td></td>
<td>2.94 (1.23)&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>4.34 (1.40)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.67 (1.19)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.49(2,36)&lt;sup&gt;**&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Note. For all measures, n=39. For each measure, matching superscript letters indicate a significant difference between two conditions.

* *p<.05
** *p<.01
Table 3

Demographic Characteristics of Study 2 Sample

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>M(SD) or %(n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>21.41 (4.60)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>51% (20)</td>
</tr>
<tr>
<td>Female</td>
<td>49% (19)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
</tr>
<tr>
<td>White/European</td>
<td>90% (35)</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>3% (1)</td>
</tr>
<tr>
<td>Black/African American</td>
<td>3% (1)</td>
</tr>
<tr>
<td>Other</td>
<td>5% (2)</td>
</tr>
<tr>
<td>Age When First Smoked (years)</td>
<td>15.89 (2.28)</td>
</tr>
<tr>
<td>Dollars spent on cigarettes/week</td>
<td>27.50 (8.76)</td>
</tr>
<tr>
<td>How often smoke/week? (past 6 months)</td>
<td></td>
</tr>
<tr>
<td>7 days</td>
<td>95% (37)</td>
</tr>
<tr>
<td>5-6 days</td>
<td>5% (2)</td>
</tr>
<tr>
<td>How many packs/day? (past 6 months)</td>
<td></td>
</tr>
<tr>
<td>1 pack</td>
<td>74% (29)</td>
</tr>
<tr>
<td>More than 1 but less than 2</td>
<td>15% (6)</td>
</tr>
<tr>
<td>Less than 1 pack</td>
<td>10% (4)</td>
</tr>
<tr>
<td>How long smoked pack/day?</td>
<td></td>
</tr>
<tr>
<td>3 months-1 year</td>
<td>41% (16)</td>
</tr>
<tr>
<td>1-3 years</td>
<td>33% (13)</td>
</tr>
<tr>
<td>3 or more years</td>
<td>26% (10)</td>
</tr>
<tr>
<td>With whom do you typically smoke?</td>
<td></td>
</tr>
<tr>
<td>Friends</td>
<td>77% (30)</td>
</tr>
<tr>
<td>Alone</td>
<td>23% (9)</td>
</tr>
</tbody>
</table>

Note. Table 3 continues on the subsequent page.
Table 3 (contd.)

*Demographic Characteristics of Study 2 Sample*

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>M(SD) or % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree to which use under control?</td>
<td></td>
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<tr>
<td>Somewhat/completely under my control</td>
<td>54% (21)</td>
</tr>
<tr>
<td>Somewhat/completely out of my control</td>
<td>46% (18)</td>
</tr>
<tr>
<td>How easy/difficult to abstain in next month?</td>
<td></td>
</tr>
<tr>
<td>Somewhat/very difficult</td>
<td>97% (38)</td>
</tr>
<tr>
<td>Somewhat easy</td>
<td>3% (1)</td>
</tr>
<tr>
<td>Number of Quit Attempts</td>
<td></td>
</tr>
<tr>
<td>Less than 3</td>
<td>44% (17)</td>
</tr>
<tr>
<td>3-5</td>
<td>33% (13)</td>
</tr>
<tr>
<td>6 or more</td>
<td>23% (9)</td>
</tr>
<tr>
<td>Level of Dependence (FTND score)</td>
<td></td>
</tr>
<tr>
<td>Low (3-4)</td>
<td>44% (17)</td>
</tr>
<tr>
<td>Medium-High (5-7)</td>
<td>36% (14)</td>
</tr>
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<td>Very low (0-2)</td>
<td>21% (8)</td>
</tr>
<tr>
<td>Hours abstained prior to participation</td>
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</tr>
<tr>
<td>More than 10</td>
<td>59% (23)</td>
</tr>
<tr>
<td>6-10</td>
<td>41% (16)</td>
</tr>
</tbody>
</table>

Note. For all items, n=39. Due to rounding, proportions may not equate to 100%.
Table 4

*Mean and Standard Deviation Scores for Dependent Measures and Manipulation-Check Measures in Study 2*

<table>
<thead>
<tr>
<th>Measures</th>
<th>Condition</th>
<th>NVT</th>
<th>SVT</th>
<th>CVT</th>
<th>F(df) or t(df)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QSU-Brief Factor 1 Change score</td>
<td></td>
<td>-0.18 (0.53)</td>
<td>-0.25 (0.77)</td>
<td>-0.48 (0.71)</td>
<td>0.67 (2,36)</td>
</tr>
<tr>
<td>QSU-Brief Factor 2 Change score</td>
<td></td>
<td>-0.31 (0.87)</td>
<td>-0.27 (0.93)</td>
<td>-0.12 (0.69)</td>
<td>0.19 (2,36)</td>
</tr>
<tr>
<td>Retro-VAS-Craving</td>
<td></td>
<td>73.51 (11.89)</td>
<td>51.73 (26.07)</td>
<td>49.49 (26.23)</td>
<td>4.55 (2,36)*</td>
</tr>
<tr>
<td>Vividness Change score</td>
<td></td>
<td>-0.40 (0.96)</td>
<td>-0.90 (0.75)</td>
<td>-1.33 (1.04)</td>
<td>3.24 (2,36)</td>
</tr>
<tr>
<td>Effort score</td>
<td>---</td>
<td>8.47 (1.03)</td>
<td>8.27 (0.61)</td>
<td>0.60 (19)</td>
<td></td>
</tr>
</tbody>
</table>

Note. For all measures except the Effort survey, n=39. For the Effort survey, n=26 because this measure was employed only in the SVT and CVT conditions. For each measure, matching superscript letters indicate a significant difference between conditions.

* p<.05
Item 1

The Questionnaire of Smoking Urges-Brief (QSU-Brief)

Indicate how much you agree or disagree with each of the following statements by placing a single checkmark along each line between STRONGLY DISAGREE and STRONGLY AGREE. The closer you place your checkmark to one end or the other indicates the strength of your agreement or disagreement. We are interested in how you are thinking and feeling right now as you are filling out the questionnaire.

1. I have a desire for a cigarette right now.
   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

2. Nothing would be better than smoking a cigarette right now.
   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

3. If it were possible, I probably would smoke now.
   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

4. I could control things better right now if I could smoke.
   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

5. All I want right now is a cigarette.
   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

6. I have an urge for a cigarette.
   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

7. A cigarette would taste good right now.
   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

8. I would do almost anything for a cigarette now.
   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

9. Smoking would make me less depressed.
   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

10. I am going to smoke as soon as possible.
   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE
Item 2

Vividness Survey

1. My mental image of cigarettes was **vivid** at that time.

   0 1 2 3 4 5 6
   not at all somewhat extremely vivid

2. My mental image of cigarettes was **detailed** at that time.

   0 1 2 3 4 5 6
   not at all somewhat extremely detailed

3. My mental image of cigarettes was **vague** at that time.

   0 1 2 3 4 5 6
   not at all somewhat extremely vague

4. My mental image of cigarettes was **fuzzy** at that time.

   0 1 2 3 4 5 6
   not at all somewhat extremely fuzzy

5. Did you imagine smoking a cigarette during the imagery exercise? (circle)

   Yes   No

Instructions for **Study 1 DVSI** condition:
Please mark how accurately the following words describe your experience **after imagining taking the last step away** from the scene in the picture.

Instructions for **Study 1 IVSI** condition:
Please mark how accurately the following words describe your experience **after imagining taking the last step toward** the scene in the picture.

Instructions for **Study 1 NCSI** condition:
Please mark how accurately the following words describe your experience **after imagining the scene** in the picture.

Instructions for **Study 2**:
Please mark how accurately the following words describe your feelings **RIGHT NOW**.
(Items 1-4 were changed to reflect concurrent rating of craving and item 5 was eliminated.)
Item 3

The Fagerström Test for Nicotine Dependence (FTND)

1. How soon after you wake up do you smoke your first cigarette?
   a. Within 5 minutes
   b. 6-30 minutes
   c. 31-60 minutes
   d. After 60 minutes

2. Do you find it difficult to refrain from smoking in places where it is forbidden (for example, in church, at the library, in the cinema, etc.)?
   a. Yes
   b. No

3. Which cigarette would you hate most to give up?
   a. The first one in the morning
   b. All others

4. How many cigarettes/day do you smoke?
   a. 10 or less
   b. 11-20
   c. 21-30
   d. 31 or more

5. Do you smoke more frequently during the first hours after waking than during the rest of the day?
   a. Yes
   b. No

6. Do you smoke if you are so ill that you are in bed most of the day?
   a. Yes
   b. No
Item 4

Demographic Questionnaire

Please answer the following questions about yourself.

1. What is your age? _________

2. What is your sex?
   Female
   Male

3. What is your race/ethnicity?
   Asian/Pacific Islander
   Black/African American
   Hispanic/Latino
   Native American/Aleutian
   White/European
   Other _________________

4. In the last 6 months, how many **days a week** on average have you smoked cigarettes?
   0
   1
   2
   3
   4
   5
   6
   7

5. In the last 6 months, how many cigarettes do you smoke **on a daily basis**?
   Less than 1 pack a day
   1 pack a day
   More than 1 pack but less than 2 packs a day
   2 or more packs a day

6. About how much money do you spend on tobacco **in a typical week**? ______

7. How long have you been smoking **at least one pack of cigarettes a day**?
   Less than 3 months
   3 to 6 months
   6 months to 1 year
   1 to 2 years
   2 to 3 years
   3 or more years
8. How old were you when you first smoked cigarettes? ______

9. When you smoke, who are you usually with (check one)?
   __ alone   __ with friends   __ with family

10. **Circle** the answer below that best describes the degree to which your use of tobacco is under your control:

    Completely **under** my control   Somewhat **under** my control   Somewhat **out of** my control   Completely **out of** my control

11. **Circle** how easy or difficult it would be for you to go without using tobacco for the next month?

    Very easy   Somewhat easy   Somewhat difficult   Very difficult

12. How many times have you attempted to quit smoking cigarettes?

    0
    1
    2
    3
    4
    5
    6
    7
    8
    9
    10 or more

13. When was the date (for example, 03/11/06) and time of day (for example, 9:30 p.m.) of your last cigarette?

    Date: _________
    Time: _________
Item 5

Guided Imagery Script – Increasingly Vivid Smoking Imagery

Here is a picture of an office. On the table, you may be able to see a book of matches, a pack of cigarettes, and an ashtray with a cigarette in it. Take a moment to look at this picture. (Speaker pauses 10 seconds.) I am going to ask you to imagine this scene in a minute, but it is important that you know that you are not to imagine actually smoking a cigarette while imagining this scene or during the rest of our session today.

Now, I want you to close your eyes and hold in your mind for a few seconds the image of the picture you just looked at. (Researcher removes stimulus picture.) Just imagine the scene exactly the way it looked in the picture. (Speaker pauses 10 seconds.)

Now, I want you to imagine taking one step closer to the table. Everything on the table should seem a bit easier to see. Keep this scene in your mind until I speak again. (Speaker pauses 10 seconds.)

Now I want you to imagine taking one more step closer to the table. Again, everything on the table should seem clearer to you. You can imagine more vividly the ashtray with the cigarette in it, the pack of cigarettes, and the book of matches. Keep this scene in your mind until I speak again. (Speaker pauses 10 seconds.)

Now I want you to imagine taking one more step closer to the table. At this point, you are about 2 steps away from the table. Imagine you can read the words on the cigarette package. You can see clearly the cigarette sticking out of the ashtray. Imagine you can see the book of matches lying next to the ashtray. Keep this scene in your mind until I speak again. (Speaker pauses 10 seconds.)

Take one last step toward the table. As you look down at the top of the table, everything on top of it looks so clear. You see the cigarettes sticking out of the corner of the cigarette pack. You can read the words on the cigarette package, even the small print. You can see what the matchbook looks like. You can see the ashtray with the single white cigarette hanging off the side. Keep this scene in your mind until I speak again. (Speaker pauses 10 seconds.) Now, open your eyes.
Item 6

Guided Imagery Script – Decreasingly Vivid Smoking Imagery

Here is a picture of an office. On the table, you may be able to see a book of matches, a pack of cigarettes, and an ashtray with a cigarette in it. Take a moment to look at this picture. (Speaker pauses 10 seconds.) I am going to ask you to imagine this scene in a minute, but it is important that you know that you are not to imagine actually smoking a cigarette while imagining this scene or during the rest of our session today.

Now, I want you to close your eyes and hold in your mind for a few seconds the image of the picture you just looked at. (Researcher removes stimulus picture.) Just imagine the scene exactly the way it looked in the picture. (Speaker pauses 10 seconds.)

Now, I want you to imagine taking one step back. Everything on the table should seem a bit harder to see. Keep this scene in your mind until I speak again. (Speaker pauses 10 seconds.)

Now I want you to imagine taking one more step back. Again, everything on the table should seem more difficult to see and that’s okay. You know that there is an ashtray, a book of matches, and a pack of cigarettes on the table but it is harder to see. Keep this scene in your mind until I speak again. (Speaker pauses 10 seconds.)

Now I want you to imagine taking one more step back. At this point, you are about 7 steps away from the table. Imagine you can no longer read the words on the cigarette package. The pack just looks like a small rectangular box standing on the table. Imagine you can no longer make out the book of matches because it’s blending into the table top. Imagine the ashtray now looks like a small white dish. Everything on the table seems out of focus, now and that’s okay. Keep this scene in your mind until I speak again. (Speaker pauses 10 seconds.)

Take one last step back, away from the table. You can imagine the table and the book shelves, but everything on the table is blurry now. It is harder to see and that’s okay. Imagine that everything is out of focus. Keep this scene in your mind until I speak again. (Speaker pauses 10 seconds.) Now, open your eyes.
Guided Imagery Script – No Change in Smoking Imagery

Here is a picture of an office. On the table, you may be able to see a book of matches, a pack of cigarettes, and an ashtray with a cigarette in it. Take a moment to look at this picture. (Speaker pauses 10 seconds.) I am going to ask you to imagine this scene in a minute, but it is important that you know that you are not to imagine actually smoking a cigarette while imagining this scene or during the rest of our session today.

Now, I want you to close your eyes and hold in your mind for a few seconds the image of the picture you just looked at. (Researcher removes stimulus picture.) Just imagine the scene exactly the way it looked in the picture. (Speaker pauses 10 seconds.)

Now, I want you to continue imagining the scene exactly the way it looked in the picture. You may find that your mind wanders from the picture to other things …. that’s okay, just slowly bring the picture back to your mind. Everything should look exactly the same. Keep this scene in your mind until I speak again. (Speaker pauses 10 seconds)

Now, I still want you to keep imagining the picture as you saw it before. I realize this may seem difficult to do, but keep that picture in your mind. Everything should look the same to you. You can imagine the scene in the picture exactly the way you saw it before. Keep this scene in your mind until I speak again. (Speaker pauses 10 seconds.)

Once again, I want to concentrate your mind on the picture. You may find that your mind wanders from the picture to other things …. that’s okay, just slowly bring the picture back to your mind. Imagine the scene exactly as it appeared in the picture. Keep this scene in your mind until I speak again. (Speaker pauses 10 seconds.)

Let’s have one last experience of imagining the scene in the picture. I know I am repeating myself, and that you’ve been imagining the picture for some time now, but I want you to once again re-focus your concentration on the scene. You can see the scene in your mind exactly as it appeared in the picture. Keep this scene in your mind until I speak again. (Speaker pauses 10 seconds.) Now, open your eyes.
Beach Scene Imagery

You are sitting on the beach attending to the various smells and sights around you. You notice the smell of laundry soap coming from your orange beach towel. Next, you notice as the person next to you squirts white suntan lotion from a brown bottle into their hand. The person is so close you can smell the lotion’s coconut scent and you watch as the person slowly rubs in the lotion until the white color disappears. The smell of the lotion is replaced by the fresh air blowing in from the water. You look up and see a young, blonde haired boy throw a bright green Frisbee to another boy. You watch as they throw the Frisbee high and dive to catch it before it hits the sand. Suddenly you smell a wet dog. You look toward the water and see a long-haired dog leaping and swimming into the waves to retrieve a stick. As you continue to sit on the beach, you take in all the scenes and smells (your beach towel, the person applying lotion, the fresh air, the boys playing, and the dog).
Item 9

Outline of Phase 1 Procedure

Potential subjects contacted via experimetrix, class announcement, email

Potential subject responds to recruitment; Eligibility confirmed

Subject arrives for appointment; Eligibility re-confirmed

Participants give informed consent

Participants complete QSU-Brief$_1$ (baseline craving)

Exposure to IVSI Exposure to DVSI Exposure to NCSI

Complete QSU-Brief$_2$, Vividness survey, the FTND, and a demographic survey

Exposure to beach scene imagery

Determine if additional beach imagery is warranted to reduce craving to baseline levels

Participants debriefed and entered into a participant lottery and/or provided experimental credit

**Key for Phase 1 Outline**

IVSI=Increasingly Vivid Smoking Imagery
DVSI=Decreasingly Vivid Smoking Imagery
NCSI=No Change in Smoking Imagery
QSU-Brief=concurrent measure of craving
FTND=measure of nicotine dependence
Item 10

Effort Survey

The items below ask you to indicate how much effort you put into various aspects of the computer task. The closer you place your checkmark to one end or the other indicates the intensity of your effort.

1. How much effort did you put into **watching** the symbols on the computer screen?

   NO                          INTENSE
   EFFORT                     AMOUNT
   AT ALL ___: ___: ___: ___: ___: ___: ___: ___: ___: ___ OF EFFORT

2. How much effort did you put into **thinking about** the symbols on the computer screen?

   NO                          INTENSE
   EFFORT                     AMOUNT
   AT ALL ___: ___: ___: ___: ___: ___: ___: ___: ___: ___ OF EFFORT

3. How much effort did you put into **paying attention to** the symbols on the computer screen?

   NO                          INTENSE
   EFFORT                     AMOUNT
   AT ALL ___: ___: ___: ___: ___: ___: ___: ___: ___: ___ OF EFFORT

4. How much effort did you put into **focusing on** the symbols on the computer screen?

   NO                          INTENSE
   EFFORT                     AMOUNT
   AT ALL ___: ___: ___: ___: ___: ___: ___: ___: ___: ___ OF EFFORT

5. How much effort did you put into **concentrating on** the symbols on the computer screen?

   NO                          INTENSE
   EFFORT                     AMOUNT
   AT ALL ___: ___: ___: ___: ___: ___: ___: ___: ___: ___ OF EFFORT

6. How much effort did you put into **identifying** the symbols on the computer screen?

   NO                          INTENSE
   EFFORT                     AMOUNT
   AT ALL ___: ___: ___: ___: ___: ___: ___: ___: ___: ___ OF EFFORT

7. How much effort did you put into **memorizing** the symbols on the computer screen?

   NO                          INTENSE
   EFFORT                     AMOUNT
   AT ALL ___: ___: ___: ___: ___: ___: ___: ___: ___: ___ OF EFFORT
Item 11

Retrospective VAS Rating of Craving (Retro-VAS-Craving)

1. **Think back to when you were watching the computer screen.**

Rate how much you **craved** a cigarette **at that time** (while you were watching the computer screen) on a scale of 0 to 100 (0 being the least amount of craving you’ve ever experienced and 100 being the highest amount of craving you’ve ever experienced).

_____________

2. **Think back to when you were watching the computer screen.**

Rate how much you **needed** a cigarette **at that time** (while you were watching the computer screen) on a scale of 0 to (0 being the least amount of craving you’ve ever experienced and 100 being the highest amount of craving you’ve ever experienced).

_____________

3. **Think back to when you were watching the computer screen.**

Rate how much you **desired** a cigarette **at that time** (while you were watching the computer screen) on a scale of 0 to 100 (0 being the least amount of craving you’ve ever experienced and 100 being the highest amount of craving you’ve ever experienced).

_____________

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**Instructions for the NVT condition:**

**Think back to when you were resting your hands/taking a break.** Rate how much you [**craved/needed/wanted**] a cigarette **at that time** (while you were watching the computer screen) on a scale of 0 to 100 (0 being the least amount of craving you’ve ever experienced and 100 being the highest amount of craving you’ve ever experienced).
Item 12

Symbols Displayed in the Simple Visual Task

Symbol/Screen Settings of SVT

**Resolution:** Highest (set at 10 on 10-point scale)

**Size:** Largest (set at 10 on 10-point scale)

**Rotation Speed:** Relatively slow (set at 4 on 20-point scale)

**Rotation Type:** See Saw

**Solid Color**
Item 13

Symbols Displayed in the Complex Visual Task

[ a  b  v  Y  s  h  E  O  J  N ]

NO spaces between each letter
text set on webdings

Symbol/Screen Settings of CVT

Resolution: Highest (set at 10 on 10-point scale)
Size: Largest (set at 10 on 10-point scale; although this is the same setting as SVT, the actual size of CVT symbols was relatively smaller because a greater number of symbols were displayed in the CVT)
Rotation Speed: Relatively fast (set at 11 on 20-point scale)
Rotation Type: Spin
Solid Color
Item 14

Cue Exposure Script

On the table, you will see an ashtray, a pack of cigarettes, and a lighter. Take a moment to look at these objects. (Speaker pauses 5 seconds.)

Now, I want you to take a cigarette out of the pack. When you have done so, without putting the cigarette up to your mouth, hold the cigarette as you normally would. As you do this, focus on the feel of the cigarette. Imagine what it would be like to have one right now. Keep imagining this until I speak again. (Speaker pauses 5 seconds.)

Now, take a moment to smell the cigarette. Continue holding the cigarette and imagine what it would be like to have one right now. (Speaker pauses 5 seconds.)

Now place the cigarette back on the tray. At this time, the researcher is going to light the cigarette. As she does this, pay attention to the sound of the lighter and the smell of the cigarette as it is lit. (Researcher lights the cigarette and places the lit cigarette in the ashtray in front of the participant during 5-second pause.)

Now, pay attention to the sight of the smoke as it slowly curls and rises above the ashtray. Keep paying attention to the sight and the smell of the cigarette and imagine what it would be like to have one right now. (Speaker pauses 5 seconds.)

Now, the researcher is going to put the cigarette out. Keep focusing on the sight and the smell of the cigarette until I speak again. (Researcher extinguishes the cigarette in the ashtray during a 5-second pause.) You have now completed this component of the project.
Item 15

SVT Symbol-Identification Task

During the computer task, you saw a grouping of symbols. In each of the items below, you will find one of the symbols from the computer exercise. For each item, please circle the symbol that you saw on the computer screen during the computer exercise.

1.  
2.  
3.  
4.  
5.  
6.  

[Symbol images are shown for each item.]
Item 16

CVT and NVT Symbol-Identification Task

Instructions for CVT condition:
During the computer task, you saw a grouping of symbols. In each of the items below, you will find one of the symbols from the computer exercise. For each item, please circle the symbol that you saw on the computer screen during the computer exercise.

Instructions for NVT condition:
For each item below, please circle the symbol that is most interesting or appealing to you.

1. [Symbol Image]
2. [Symbol Image]
3. [Symbol Image]
4. [Symbol Image]
5. [Symbol Image]
6. [Symbol Image]
7. [Symbol Image]
8. [Symbol Image]
9. [Symbol Image]
10. [Symbol Image]
Item 17

Park/Playground Imagery

You are sitting on a park bench, watching the people and activity around you. You notice the smell of freshly cut grass as a steady, gentle breeze cools your face. It is an early, morning in Spring and the sun is out. In the distance, you can hear the chains of a swing-set faintly squeak as a child swings high in the air and then back down again. Next to you, children play soccer. Their shoes and soccer ball are stained bright green by the damp grass. As they move past you, the smell of freshly cut grass is replaced by the faint scent of coconut suntan lotion that protects their noses and cheeks. You look over at a park bench near you and see a mother and child. Beside them, pigeons rummage through the grass. You notice as the mother scatters bread crumbs on the ground and gives a handful to her child to throw. The birds chirp as they flutter from bread crumb to bread crumb. The fresh smell of evergreen trees fill the air as the breeze gently rustles the trees around you. As you continue to rest on the bench, you take in all the scenes and smells (the freshly cut grass, the gentle breeze, the child swinging, the children playing soccer, the mother and child scattering bread crumbs, the birds chirping, and the evergreens).
Item 18

Outline of Phase 2 Procedure

Potential subjects contacted via experimetrix, class announcement, email

Potential subject responds to recruitment; Eligibility confirmed

Subject arrives for appointment; Eligibility re-confirmed

Participants give informed consent

Participants complete QSU-Brief\(_1\) (baseline craving)

Cue exposure

Complete QSU-Brief\(_2\) and Vividness Items\(_1\)

Exposure to SVT  Exposure to CVT  Exposure to NVT

Participants complete the QSU-Brief\(_3\), Vividness survey, Retro-VAS, Effort survey, a symbol identification survey, the FTND, and a demographic survey

Exposure to park/playground imagery

Determine if additional park/playground imagery is warranted to reduce craving to baseline levels

Participants debriefed and entered into a participant lottery and/or provided experimental credit

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**Key for Phase 2 Outline**

QSU-Brief=concurrent measure of craving

SVT=Simple Visual Task

CVT=Complex Visual Task

NVT=No Visual Task

FTND=measure of nicotine dependence

Retro-VAS=retrospective measure of craving