THE EFFECTS OF SMOKING AVAILABILITY AND ENVIRONMENTAL SMOKING CUES ON SMOKING MOTIVATION

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Submitted to the

Faculty of the College of Arts and Sciences

of American University

in Partial Fulfillment of

the Requirements for the Degree of

Master of Arts

In

Psychology

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Date

February 19, 2019

2019

American University

Washington, D.C. 20016
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ABSTRACT

Conditioned reactions (e.g., cravings) to drug-related stimuli (e.g., objects, emotions, or situations associated with drug taking) have been examined as a potential mechanism to explain the maintenance of drug use and relapse. There is evidence that the expectation that a drug is available for consumption can enhance reactivity to environmental drug stimuli as well as possibly serve as a conditioned stimulus in its own right. Prior studies have found that smokers report greater urges to smoke when they expect to smoke sooner (e.g., 20 minutes) than later (e.g., 3 hours), with greater reactions when smoking stimuli (e.g., pack of cigarettes) are present. However, reactions to extended delays before smoking is available have not been adequately investigated (e.g., delays greater than 4 hours). Using a between-subjects factorial design, daily smokers (N=180; 112 male, 68 female) were randomized into one of six conditions in which instructions about the next available opportunity to smoke (20 minutes, 3 hours, or 24 hours) were cross with exposure to stimuli (smoking-related or neutral cues). Smoking urge, withdrawal, mood, and reaction time were assessed before and after the manipulation. Then all participants were told that they would have an opportunity to smoke and took part in a smoking versus money choice procedure for 50 minutes. Analyses revealed a main effect of availability on withdrawal symptoms, $F(2,173) = 5.414, p < .001$ and negative mood, $F(2,173) = 8.725, p < .001$, which were highly correlated ($r = .87$). Post-hoc comparisons revealed that those told 24 hours had significantly greater withdrawal symptoms and negative mood compared to those told 20 min and 3 hrs. No main effects of availability were found for urge, positive mood, or reaction time. There were also no main effects for smoking stimuli and no availability by smoking stimuli interactions. Participants who were initially exposed to neutral stimuli and then exposed to smoking stimuli during the choice procedure were more likely to smoke than those already exposed to smoking stimuli. A better understanding of the influence of cognitive and
environmental stimuli on smoking motivation and behavior may inform the development of innovative cognitive behavioral treatment strategies for smoking cessation.
ACKNOWLEDGMENTS

I would like to thank my advisor, Laura Juliano, for her invaluable guidance and expertise in the design, implementation, and write-up of this study. I also thank my committee members, Dave Haaga and Dave Kearns, for their insightful comments, feedback, and support throughout this project. I would also like to acknowledge the members of the Behavioral Pharmacology and Health Promotion Laboratory, who provided essential support for this project. Lastly, I am grateful to Chris, my family, and friends for their love, support, and encouragement throughout this project.
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CHAPTER 1
INTRODUCTION

Smoking Prevalence
Cigarette smoking remains the leading preventable cause of death and disease in the United States. It kills more than 480,000 Americans each year, with about 41,000 of those deaths caused by exposure to secondhand smoke (USDHHS, 2014). In 2016, approximately 15.5% (37.8 million) U.S. adults were current cigarette smokers, of which 76.1% were daily smokers (Jamal et al., 2018). More than 16 million Americans live with a smoking-related disease and 1 in 5 American deaths are attributed to a smoking-related illness (Jamal et al., 2016). There have been considerable advances in smoking cessation research, increased efforts to regulate tobacco products, and increased anti-tobacco advertising. Nevertheless, cigarette smoking persists to the detriment of millions of Americans.

At present even the most effective cessation treatments help only a fraction of the smokers who attempt to quit. Stead and Lancaster (2012) examined 38 randomized or quasi-randomized controlled trials in which smokers attempting to quit received pharmacotherapy as well as varying amounts of behavioral support. They found that behavioral support (in person or via telephone) had only a modest effect on treatment outcomes. Furthermore, researchers have observed that the use of pharmacotherapies still results in high failure rate among smokers aiming to achieve long-term abstinence (Cinciripini et al., 2013; Ebbert et al., 2014). Improved smoking cessation treatments are sorely needed. A greater understanding of processes underlying smoking motivation may help us to fully identify the necessary components of a successful treatment for persistent cigarette smoking.
Cue Reactivity

Learning theorists suggest that classical conditioning is an important mechanism guiding the development and maintenance of drug-taking behavior, including cigarette smoking. This idea has led to much research based on the notion that stimuli that have been repeatedly associated with nicotine (i.e., the unconditioned stimulus) produce conditioned responses, even in the absence of nicotine, that increase smokers’ motivation to smoke and drive subsequent behavior (Rose, 1996). Cue reactivity research involves identifying the stimuli that cause presumed conditioned responses in the laboratory, as well as examining the nature and consequences of such reactions. Smoking-related conditioned stimuli can be categorized in a number of ways, including environmental stimuli (e.g., pack of cigarettes, lighter/ashtray, seeing others smoking) (Carter & Tiffany, 2001; Juliano & Brandon, 1998; Ross & Juliano, 2015, Wertz & Sayette, 2001), emotions (e.g., stress-precipitated tobacco relapse) (McKee et al., 2011), and sensorimotor aspects of smoking (e.g., sensations in throat and mouth, holding a cigarette, act of bringing cigarette to mouth) (Rose, Behm, Westerman, Bates, & Salley, 2003). There has been a substantial amount of research examining the relationship between cue reactivity and purported indices of smoking motivation. Some laboratory based studies have found that exposure to smoking-related cues increases self-reported urge to smoke (Carter & Tiffany, 2001; Field & Duka, 2001; Juliano & Brandon, 1998; Lazev, Herzog, & Brandon, 1999; Wertz & Sayette, 2001a), negative mood (Carter & Tiffany, 2001), and physiological responses (e.g., brain activity, heart rate, skin conductance) (McBride, Barrett, Kelly, Aw, & Dagher, 2006; Carter & Tiffany, 1999).

In addition to establishing a link between cue reactivity and smoking motivation, it is important to determine if cue reactivity affects actual smoking-related behaviors (e.g., drug procurement and use). Some, but not all, studies have shown that cue reactivity impacts actual
smoking behavior. Payne, Schare, Levis, and Colletti (1991) found that exposure to smoking-related cues increased smoking behavior (e.g., number of cigarettes smoked, smoking duration, number of puffs taken, inter-puff interval). Conklin et al. (2015) found that exposure to smoking-related cues predicted strong self-reported craving, as well as increases in subsequent smoking behavior, including shorter latency to smoke, and greater number of puffs and puff volume, relative to exposure to neutral cues. Moreover, exposure to smoking-related cues predicts more difficulty initiating quitting and greater probability of smoking lapse and relapse after a quit attempt (Abrams, Monti, Carey, Pinto, & Jacobus, 1988; Niaura, Abrams, Demuth, Pinto & Monti, 1989; Waters, Shiffman, Sayette, Paty, Gwaltney, & Balabanis, 2004; Shiffman et al., 1997). In fact, cue-induced craving has been shown to predict relapse and following a quit attempt, and can persist even after the abstinence-induced craving declines (Shadel, Niaura, & Abrams, 2001; Shiffman, Paty, Gnys, Kassel, & Hickcox, 1996; Shiffman et al., 1997).

However, not all studies have found that cue reactivity predicts smoking behavior. Shiffman and colleagues (2013a) used a 3-minute acclimation and 3-minute cue exposure period (i.e., 30 cue images shown for 6 seconds each) to expose different cues to intermittent and daily smokers across 6 experimental sessions (one cue per session). They selected cues that were thought to influence craving and smoking (i.e., smoking, alcohol cues, negative and positive affect, and smoking prohibitions). They found that although craving predicted smoking, cue exposure had little influence on actual smoking behavior. They used the same cues in another study (Shiffman et al., 2013b) and again found no evidence of effects of cues on any measures of smoking behavior. The only cues that increased craving were those that depicted cigarettes and the act of smoking (i.e., proximal cues). Affective cues changed smokers’ affect, but unlike other studies (Perkins, Karelitz, Conklin, Sayette, & Giedgowd, 2010; Tiffany & Drobes, 1990), these cues did not elicit change in craving (i.e., positive affect cues resulted in increased positive affect
and decreased craving; negative affect cues yielded no effect, even though they elicited emotional distress). Both studies (Shiffman et al., 2013a, 2013b) demonstrated that their level of cue reactivity was modest, which suggests that their cues did not induce strong enough craving to elicit actual subsequent smoking behavior.

Other researchers have surprisingly found that greater cue reactivity is associated with better smoking outcomes. For example, Conklin, Parzynski, Salkeld, Perkins, and Fonte (2012) recruited 172 daily smokers to complete 12 cue exposure trials (6 pictorial smoking cues, 6 pictorial neutral cues) and measures of cue-elicited craving, negative affect, and positive affect. Within 7 days of the cue exposure sessions, participants participated in a simulated quit attempt, where they were instructed to ad lib smoke on weeks 1 and 3 and attempt to quit using NRT on weeks 2 and 4 (Conklin et al., 2012). Using a short-term simulated quit attempt, they found some evidence for the functionality of smoking cue-induced craving in predicting a smoker’s ability to initiate abstinence (Conklin et al., 2012). Specifically, they found that smokers who reported greater craving in response to smoking cues had a higher likelihood of successfully initiating a short-term quit attempt, which is contrary to the commonly-held hypothesis that a smoker who experiences greater cue-induced craving should have a harder time initiating a quit attempt.

Niaura, Rohsenow, Binkoff, Monti, Pedraza, and Abrahams (1988) found that with more cue-exposure sessions and increased cue-induced craving, the time to relapse among smokers became longer. Powell, Dawkins, West, Powell, and Pickering (2011) found that smokers with greater cue reactivity before making a quit attempt were less likely to relapse. Further, McClernon, Kozink, Lutz, & Rose (2009) found that individuals who were able to successfully abstain from smoking showed greater pre-treatment activation in the thalamus and ventral striatum as a function of smoking cues.
Based on these intriguing findings one could hypothesize that cue reactivity may reflect active cognitive processes, which are in preparation for attempting to quit smoking among those smokers who intend to quit. The increased awareness of the saliency of smoking-related cues may reveal effortful processing of their intention to abstain from smoking (Tiffany, 1990). In fact, attentional biases for smoking-related words (i.e., Stroop test) have been shown to be associated with cessation outcomes in smokers (Waters, Shiffman, Sayette, Paty, Gwaltney, & Balabanis, 2003). Franken (2003) argues that the relationship between attentional bias and craving is bidirectional, in that attentional bias can cause or increase craving and craving can cause attentional bias. Waters, Szeto, Wetter, Cinciripini, Robinson, and Li (2014) built on this idea by examining attentional bias as a correlate of craving using EMA. They found a significant between-subject relationship between craving and the smoking Stroop effect (a reaction time task measuring attentional bias), and individuals with higher levels of craving showed greater attentional bias (Waters et al., 2014). Therefore, if a smoker who is attempting to quit tries to avoid thinking about smoking and smoking-related stimuli; according to this theory, the opposite effect would occur and the smoker would experience smoking-related cognitions more prominently (Conklin et al., 2012). This supposition has been found in fMRI research as well, with Brody and colleagues (2007) finding greater limbic activation when smokers were told to ‘resist’, rather than actively crave, a cigarette. Thus, it appears that cognitive factors seem to play a large role in cue reactivity research. The focus of many early cue reactivity studies has been on reactions to environmental stimuli and interoceptive affective states; however, the conditions surrounding cigarette procurement and administration appears to involve other areas, like cognitive factors. The availability of the drug is one cognitive factor that has been subject to some investigation. The belief that cigarettes are available for consumption may become conditioned stimuli independent of environmental cues, or availability may moderate
conditioned responding to environmental stimuli. To further examine the role of cognitive factors and availability, it is crucial that we consider different theories that may explain the role of availability within cue reactivity research.

**Theoretical Propositions of Smoking Availability**

Different theories of learning might presuppose that smoking availability (i.e., the opportunity to use a drug) may play a role in cue reactivity. For example, the belief that cigarettes are available likely precedes smoking behavior. As a result, multiple pairings with the drug (i.e., unconditioned stimulus; US) occur, and the belief that cigarettes are available may itself become a conditioned stimulus (CS) that elicits urges and other conditioned responses (CRs), independent of environmental cues (Juliano & Brandon, 1998). There is also the possibility that availability may moderate conditioned responding to environmental stimuli (Powell, 1995; Turkkan, McCaul, & Stitzer, 1989). That is, US-CS pairings are consistently made within the context of availability; therefore, availability may be required to signal the relationship between the US (i.e., cigarette) and the CS (i.e., lighter) for conditioned responding to occur (Juliano & Brandon, 1998). Thus, availability may serve as an “occasion setter” or discriminative stimulus that signals the connection between drug-related stimuli and the drug (Lazev, Herzog, & Brandon, 1999; Wertz & Sayette, 2001a). Finally, consistent with Pavlov (1927)’s inhibition of delay, it is possible that there is a moderating effect of availability on conditioned responding. Expectation of smoking a long time from now is similar to a very long CS which could suppress smoking-related CRs early in the CS (Pavlov, 1927). Taken together, each of these three theories would predict that the belief that the drug (e.g., cigarette) is available should provoke greater conditioned responding than the belief that the drug is unavailable. Moreover, according to Tiffany’s (1990) model of drug urges, urges should be associated with interference on concurrent tasks that also require nonautomatic processing.
It is also plausible that drug unavailability may generate greater cue reactivity than drug availability or that a greater time before a drug is available will elicit greater reactivity. Wikler (1973), for example, posited that cues associated with withdrawal can elicit withdrawal reactions. Based on Wikler’s conditioned withdrawal theory, it is possible that drug unavailability can increase cue reactivity, as it is likely that unavailability has been paired with withdrawal on many occasions. Brehm and Brehm’s (1981) psychological reactance theory asserts that when people are restricted in some way, they are driven to resist and fight back to restore their loss of freedom. Therefore, it is possible that smokers may experience an increase in urge and motivation to smoke when restrictions are placed on smoking availability. Similarly, if drug unavailability in the presence of cues leads to attempts to reduce urges, a “rebound effect” may occur and urges to use the drug (i.e., unwanted thoughts) may appear more prominently (Wegner, 1994). Within the drug literature, evidence of this effect was first identified with alcohol urges (Palfai, Monti, Colby, & Rohsenow, 1997), but more recently, Sayers and Sayette (2013) found powerful craving rebound effects among cigarette smokers who used suppression when receiving a cued smoking-craving manipulation.

As discussed thus far, several theories have been identified in the drug behavior literature for drug unavailability and urge. When considering the impact of drug unavailability on mood, Baker, Morse, and Sherman’s (1987) dual-affect model of craving should be discussed. It states that urge can be associated with positive and negative affect depending on information about when a drug is available or not. More specifically, it predicts that urge is elicited with positive affect when cigarettes are available and negative affect when cigarettes are unavailable.

**Smoking Availability Research**

Various studies have shown that when smoking is considered ‘available’, urge is greater than when smoking is considered ‘unavailable’ (Carter & Tiffany, 2001; Droungas, Ehrman,
Childress, & O’Brien, 1995; Juliano & Brandon, 1998; Wertz & Sayette, 2001a, 2001b). Drug availability has been defined differently among studies (e.g., drug opportunity); however, Carter and Tiffany (2001) categorized drug availability as ‘local availability’ and unavailability as ‘distal availability’. Local availability refers to the ability to access and use the drug within the experimental session, whereas distal availability is described as not being able to use the drug until after the experimental session ends (Carter & Tiffany, 2001). The times of availability and unavailability differ from study to study and offer nuance when investigating this mechanism of smoking behavior. See Table 1 for summaries of relevant smoking availability studies in the literature.

Droungas and colleagues (1995) were among the first to manipulate smoking availability in an experimental setting. They randomly assigned participants to a group that could smoke following a cue reactivity session or to a group where smoking was not permitted until after the study session was over. Compared to baseline, participants who were told that smoking was available reported a greater desire to smoke when presented with smoking-related cues and reported stronger craving to the smoking cues than to the neutral and unpleasant cues. Further, those in the smoking available condition reported an increase in withdrawal from baseline after exposure to the smoking cues, as well as stronger withdrawal to the smoking cues than to the neutral cues. Those exposed to smoking cues in the smoking available condition also smoked faster, compared to participants who were exposed to neutral cues in the smoking available condition.

Juliano and Brandon (1998) were next to build on the smoking availability literature and tested whether drug availability would elicit reactivity among daily smokers. They randomized participants to one of four groups, where they were exposed to neutral or smoking-related stimuli and told they can smoke within 20 minutes or in 3 hours (i.e., between-subjects 2 x 2 factorial
They found that smokers who were instructed that smoking would be available soon (i.e., 20 minutes) reported stronger urges than those who were instructed that smoking would not be available for 3 hours. Further, they found that smoking availability instructions interacted with reactivity to smoking-related stimuli such that smokers told that smoking would be available soon (i.e., 20 minutes) showed increased urge when exposed to smoking-related stimuli but not when exposed to neutral stimuli. They also found that reaction time (i.e., a purported behavioral measure of cognitive reactivity) slowed in the presence of smoking-related stimuli, only for those who were told that smoking was unavailable (e.g., 3 hours). Juliano and Brandon (1998) demonstrated that drug availability can moderate the effect of environmental stimuli in eliciting drug craving, which is consistent with Droungas et al. (1995), and also highlighted further evidence that simple reaction time is impacted by drug cue exposure while measuring different cognitive processes than urge.

Carter and Tiffany (2001) used a cue-availability paradigm to determine the effects of local cigarette availability on cue-reactivity. Across trials, daily heavy smokers were presented with a lit cigarette or cup of water behind a clear door within a stimulus box. They were instructed to look carefully at the stimuli and were presented with a 0%, 50%, or 100% chance of being able to open the door and obtain the stimuli. Carter and Tiffany (2001) found that across participants, craving was stronger for the cigarette stimuli than for the water stimuli. Further, they found a significant interaction between cue type and probability on craving and positive mood, such that when participants were exposed to smoking stimuli, craving and positive mood increased as the probability of obtaining the smoking cues increased (i.e., from 0% to 100%), while craving and positive mood remained unchanged during the water conditions, regardless of probability. As availability to cigarettes increased, negative mood significantly decreased; negative mood did not change during exposure to water cues.
Wilson, Sayette, Delgado, and Fiez (2005) expanded on these lab-based findings and developed a neuroimaging study to examine the impact of perceived smoking opportunity on the brain response to drug stimuli among abstinence-avoidant smokers. Before the fMRI scan, participants were given instructions regarding when they could next smoke (i.e., soon or a 2 hrs). Next, they were exposed to two cue presentation runs, where they were first presented with smoking-related (e.g., one of their cigarettes) or neutral cues, then instructed to hold their cigarette while being told they would or would not be able to smoke the cigarette soon (i.e., within 40 seconds). Consistent with previous research, they found that smoking cues produced differing neural activations (i.e., greater recruitment of visuospatial and auditory processing resources; Mersulam, 1998) compared to neutral cues (i.e., greater activation of memory-related processing and control of movement; DeLong, Crutcher, & Georgeopoulos, 1985; Duzel, Habib, Rotte, Guderian, Tulving, & Heinze, 2003). They also found significantly greater activation of the ACC when exposed to smoking cues than neutral cues, regardless of perceived drug availability. Since the ACC is most commonly associated with human drug craving, this finding seems to suggest that the ACC contributes to cue-elicited craving that is not affected by perceived opportunity to use the drug. Further, they found a significant interaction between instruction (i.e., smoking is available or not) and cue-elicited brain activation, such that those expecting to smoke sooner showed greater medial orbitofrontal cortex activation and less lateral orbitofrontal cortex activation. Surprisingly, they did not find an effect for smoking availability on self-reported urge.

Researchers (McBride et al., 2006; Wilson et al., 2005) have shown that the salience of stimuli associated with drug reward is intensified when found in the context of an imminent drug use opportunity. McBride et al. (2006) found that subjects exposed to smoking videos and told that they could smoke immediately after the scan showed greater activation of the DLPFC. In
fact, they found a statistically significant difference in activation between the expectant and nonexpectant subjects, suggesting that the brain response (i.e., DLPFC activation) to drug cues is modulated by expectancy to smoke (McBride et al., 2006). Little research had been done, however, examining different neural responses to neutral stimuli when drug use was expected or not. Therefore, Wilson, Sayette, Delgado, and Fiez (2008) developed an fMRI study to examine the effects of smoking opportunity on task-elicited responses in the caudate nucleus (i.e., brain region associated with reward) to a card-guessing paradigm. Expectancy of next cigarette was manipulated, in that half of the participants were told they would be able to smoke during a break in the study (i.e., soon) and the other half were told that they could not smoke during the session and would have to wait 2 hours before smoking. They found that those told they would be able to smoke during the study showed weakened caudate responses to monetary gains and losses, compared to those who thought they had to wait 2 hours to smoke. This suggests that monetary gains were perceived as less rewarding and losses as more punishing for those who anticipated smoking sooner than later.

Informed by these findings, Wertz and Sayette (2001b) conducted a meta-analysis and found a strong effect of perceived drug use opportunity, in that those expecting to use reported much stronger urges. Subsequently, much research has been conducted assessing a wide range of domains affected by perceived smoking opportunity. Expecting to smoke soon increases urge rating (Carter & Tiffany, 2001; Dols, van den Hout, Kindt, & Willems, 2002; Field & Duka, 2001), improves self-reported positive affect (Carter & Tiffany, 2001) and affect-related facial expressions (Sayette, Wertz, Martin, Perrott, & Hobel, 2003). These studies suggest that cravings can be rewarding anticipatory experiences, and that our perception of craving could be derived from what we know about relapse, not ad lib smoking. Expecting imminent smoking appears to affect the way that cues are processed, which can be seen through heightened attentional bias
toward smoking cues (Wertz & Sayette, 2001a) and altered neural responding to smoking and non-smoking cues (Wilson et al., 2005, 2008). However, it is unclear whether perceived opportunity of drug use affects underlying cognitive processes associated with drug urge or simply the reporting of urge (Juliano & Brandon, 1998).

Wertz and Sayette (2001a) investigated this further by investigating the effects of smoking opportunity on attentional bias using the emotional Stroop task. After overnight abstinence, participants were instructed that they would (‘Yes’), would not (‘No’), or might (‘Maybe’) be able to smoke during the study. They then rated their urge, mood, and completed the emotional Stroop task, which included naming the color of the word as quickly as possible. Wertz and Sayette (2001a) found a significant effect for word type, such that smokers had longer response times to smoking words than to matched words. They also found that interference to smoking words was greatest for the ‘Yes’ group (i.e., those told they would be able to smoke during the study), followed by the ‘No’ group; both interference effects were significant. Of note, these findings suggest that smoking opportunity may affect attentional bias. Urge ratings did not significantly differ across groups, but when the lightest smokers were excluded, the ‘Yes’ participants reported the highest urges than those in the ‘Maybe’ and ‘No’ groups, respectively. When looking at the direction of the data, Wertz and Sayette (2001a) found results acting in a similar pattern as found in Carter and Tiffany (2001).

The meta-analysis conducted by Wertz and Sayette (2001b) was unable to determine whether drug use opportunity impacted self-reported urge ratings even in the absence of in vivo exposure to drug cues. As a result, Sayette and colleagues (2003) aimed to build on this work by examining the effects of instructed opportunity to smoke on self-reported urge prior to in vivo exposure to smoking cues. In the study, 7-hr abstinent or non-abstinent smokers were exposed to environmental cues (e.g., roll of tape), then smoking-related cues (e.g., their pack of cigarettes,
ashtray, lighter), and were instructed to remove one cigarette from the pack, light it, and hold and look at the lit cigarette for 30 seconds. Urge was assessed at various time-points throughout the experiment, and facial coding was used to examine reactions to smoking availability and cue exposure manipulations. Sayette and colleagues (2003) found that smoking opportunity influenced self-reported urge before exposure to smoking cues, such that smokers told they would be able to smoke during the study reported higher urges than those told they would not be able to smoke. This finding broadens the results of Wertz and Sayette (2001b) in that it suggests that the opportunity to use a drug influences urge ratings even prior to in vivo exposure to smoking cues (i.e., not just during cue exposure; e.g., Wertz & Sayette, 2001b). Further, the authors found that during the smoking cue exposure, abstinent smokers were more likely to express positive action units (AUs) than were non-abstinent smokers, indicating that after a delay in smoking opportunity, being exposed to smoking cues elicits greater positive affect. This finding replicates the pattern of findings identified in a study by Sayette and Hufford (1995). Sayette and colleagues (2003) built on this experiment by designing an additional study that tested the effects of different delay periods on facial expression (i.e., thought to be associated with affect). They found that self-reported urge increased more when smokers were told they could smoke in 15 seconds, as compared to being told they could smoke in 30 or 60 seconds. This suggests that urge ratings may be influenced two-fold: by whether one expects to smoke and when one expects to smoke.

Bailey, Goedeker, and Tiffany (2010) further examined the impact of smoking availability on urge to smoke with a study manipulating both local and distal smoking availability. They conducted a study that looked at the impact of cigarette deprivation and immediate cigarette availability on reactivity measures using the cue-availability paradigm (CAP). They randomized smokers to deprived (i.e., abstinent for 24 hrs between sessions) or non-deprived
groups (i.e., smoke at usual rate between sessions). All participants were seated in front of a stimulus box, with a clear glass sliding door on front, which included a lit cigarette or cup of water inside. The CAP session consisted of 48 trials (24 cigarette, 24 water) with a 0, 50, or 100% probability of being able to open the door on each trial, and participants were instructed to look at the cues for 8 seconds and then rate craving and mood. Bailey and colleagues (2010) found that deprived smokers reported significantly higher craving than non-deprived smokers. Further, participants endorsed significantly stronger craving for cigarette trials compared to water trials, and craving became stronger as probability that the participant could open the door and sample the cue increased (but only for cigarette trials). Although no significant effects for mood were found, significant interactions between cue type and probability were found where cigarette trials yielded significantly higher negative mood and lower positive mood than water trials on the 0% probability level. This pattern was also true in the reverse, such that for the 100% probability level, negative mood significantly lowered and positive mood increased on cigarette trials as compared to water trials. Although strong main effects for cigarette deprivation and availability were found, the evidence indicating that cigarette deprivation enhanced cue-induced craving selectively was inconsistent. As a result, these findings are consistent with the idea that cigarette deprivation and exposure to smoking cues have independent and additive effects on craving.

A study by Ross and Juliano (2015) continued in this line of research and expanded on an earlier study by Juliano and Brandon (1998). They manipulated cigarette availability across three time-points (20 minutes, 3 hours, 24 hours), exposed all smokers to smoking-related stimuli, and assessed for change in mood, urge, and reaction time. They found that positive mood significantly decreased the longer that smoking was unavailable, with no significant relationship for negative mood found. Further, unlike other studies, they did not find a significant relationship
between smoking availability and urge. They attributed this to ceiling effects for urge observed at baseline. Moreover, Ross and Juliano (2015) found that smoking availability had a significant effect on reaction time, with the 24 hours condition having greater reaction time compared to the 3 hour condition. This finding replicated the work of Juliano and Brandon (1998) and provided further evidence that reaction time serves as a behavioral metric of cognitive load and correlates with self-reported urge.

Understanding smoking cues in naturalistic settings also proved an interesting avenue for research when considering smoking availability. Dar, Rosen-Korakin, Shapira, Gottlieb, and Frenk (2010) used a naturalistic study to examine behavior of cigarette-dependent flight attendants. They found that cigarette craving increased gradually during flights, when smoking was not permitted, and peaked at the end of a flight, when a smoking opportunity was imminent. Further, Dar, Stronguin, Marouani, Krupsky, and Frenk (2005) examined the effects of habitual abstinence on cigarette craving in a population of Orthodox Jewish smokers. They found that cigarette craving was lower during Sabbath (i.e., time when they were unable to smoke) in comparison to regular work days (i.e., when smoking is always available). Taken together, these results suggest that when smokers abstain from cigarette use on the same weekly occasion, they may perceive the drug as ‘unavailable’ on those days and thus experience lower craving. Similarly, Juliano and Brandon (1998) found that smokers reported stronger urges when they expected to smoke versus when they did not expect to smoke. As noted, craving has been found to increase with proximity of a smoking opportunity; therefore, it might be expected that smoking behavior increases during expected versus unexpected smoking opportunities (Schlagintweit, Greer, Good, & Barrett, 2015). Conversely, recent animal studies have suggested that when substances are delivered on a random, as opposed to a fixed schedule, there is increased responding to obtain reinforcing substances (Lagorio & Winger, 2014). These findings
suggest that imminent and unpredictable drug availability may be related to increased drug-related responding (Schlagintweit et al., 2015). Thus, it is possible that smokers may be more likely to partake in smoking-related behaviors when imminent or unexpected smoking opportunities arise (Schlagintweit et al., 2015).

Table 1. Summaries of Smoking Availability Studies

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<td>Droungas et al. (1995)</td>
<td>2 X 3 within-subject design with 2 levels of availability (yes, smoking shortly after cue exposure vs. no, smoking unavailable until after leaving) and 3 levels of stimuli (smoking, neutral, unpleasant; video and task involving cues)</td>
<td>N= 26; mean age = 20 years old, mean CPD = 15.8</td>
<td>Group told they could smoke: reported greater desire to smoke and withdrawal to smoking cues compared to baseline, greater desire to smoke to smoking cues than to other cues, smoked faster after smoking cues than neutral cues</td>
</tr>
<tr>
<td>Juliano &amp; Brandon (1998)</td>
<td>2 X 2 factorial design manipulated smoking availability (20 mins vs. 3 hrs) and stimuli (smoking vs. neutral)</td>
<td>N= 132; mean age = 33 years old, mean CPD = 27.3</td>
<td>Main effect for availability found (20 min group showed greater urge), smoking stimuli produced greater urge only for 20 min group, reaction time slower in presence of smoking cues for 3 hr group</td>
</tr>
<tr>
<td>Carter &amp; Tiffany (2001)</td>
<td>2 X 3 within-subject design with 2 levels of stimulus (cigarette vs. water) and 3 levels of probability (0% vs. 50% vs. 100%)</td>
<td>N= 60; mean age = 33 years old, mean CPD = 28</td>
<td>Stronger craving found for those exposed to smoking stimuli, significant stimuli x probability interaction found (those exposed to smoking stimuli showed increased</td>
</tr>
<tr>
<td>Study</td>
<td>Design Description</td>
<td>Participants</td>
<td>Findings</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>--------------</td>
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</tr>
<tr>
<td>Wilson et al. (2005)</td>
<td>2 X 2 factorial design manipulated smoking availability (soon/~1 hr vs. 2 hrs) and stimuli (cigarette vs. neutral) Subjects abstained for 8 hrs prior to experimental session</td>
<td>N= 22, mean age = 24.4 years old, mean CPD = 21.6</td>
<td>Significantly greater activation of the ACC when exposed to smoking cues than neutral cues, regardless of perceived drug availability, significant interaction between instruction and cue-elicited brain activation</td>
</tr>
<tr>
<td>McBride et al. (2006)</td>
<td>2 X 2 within-subjects design manipulated smoking availability (~25 mins vs. 4 hrs) and stimuli (videos of smoking vs. neutral) Subjects were scanned twice in abstinent (12 hrs) and non-abstinent (smoke as usual) states. Subjects in non-abstinent state smoked a cigarette 30 mins prior to scan.</td>
<td>N= 20, mean age = 27 years old, mean CPD = 22</td>
<td>Those exposed to smoking videos and told that they could smoke immediately showed greater activation of the DLPFC. Those told they would not be able to smoke for 4 hrs showed no brain activation to smoking cues, despite reporting equivalent levels of craving.</td>
</tr>
<tr>
<td>Wilson et al. (2008)</td>
<td>2 X 2 factorial design manipulated smoking availability (soon/~1 hr vs. 2 hrs) and stimuli (cigarette vs. neutral) Subjects abstained for 8 hrs prior to experimental session</td>
<td>N= 22, mean age = 24 years old, mean CPD = 21</td>
<td>Those told smoking is available soon showed weakened caudate responses to monetary gains and losses, compared to those who thought they had to wait 2 hrs</td>
</tr>
<tr>
<td>Wertz &amp; Sayette (2001a)</td>
<td>3 smoking availability conditions (yes, during study vs. no, 1 hr vs. maybe, 50%)</td>
<td>N= 92, mean age = 20.1 years old, mean CPD = 14.4</td>
<td>Significant effect found for word type (longer response times to smoking words), interference</td>
</tr>
<tr>
<td>Study</td>
<td>Design/Description</td>
<td>Participants</td>
<td>Findings</td>
</tr>
<tr>
<td>-------</td>
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</tr>
<tr>
<td>Sayette et al. (2003)</td>
<td>Mixed factorial design: gender, smoking level (heavy vs. light), abstinence (7-hr vs. nonabstinent) and smoking opportunity (yes, during study vs. no, after study) as between-subject factors an cue exposure (control vs. smoking) as within-subject factor, with control cue preceding smoking cue</td>
<td>N= 253, mean age = 24.6 years old, mean CPD = 14.5</td>
<td>Smokers told they would be able to smoke during the study reported higher urges than those told they would not be able to smoke, urge increased more when smokers were told they could smoke sooner than later, abstinent smokers were more likely to show greater positive affect during smoking cue exposure than non-abstinent smokers</td>
</tr>
<tr>
<td>Bailey et al. (2010)</td>
<td>2 levels of abstinence (yes, 24 hrs vs. no, smoked cigarette right before session) and cue paradigm sessions (cigarette and water) with 0, 50, or 100% chance of exposure</td>
<td>N= 119, mean age = 30 years old, mean CPD = 13.7</td>
<td>Significantly stronger craving for cigarette trials compared to water trials (craving became stronger as probability of using cue increased), cigarette trials yielded significantly higher negative mood and lower positive mood than water trials on the 0% probability level</td>
</tr>
<tr>
<td>Ross &amp; Juliano (2015)</td>
<td>Between-subjects design, exposed to smoking cues with 3 levels of smoking availability (20 mins vs. 3 hrs vs. 24 hrs) Smokers abstinent for</td>
<td>N= 90, mean age = 31.7 years old, mean CPD = 15.1</td>
<td>Significant effect of availability manipulation on positive and negative (24 hr = greater increases in negative affect and decreases in positive affect),</td>
</tr>
<tr>
<td>Study</td>
<td>Design and Methodology</td>
<td>Participants</td>
<td>Results</td>
</tr>
<tr>
<td>-------</td>
<td>------------------------</td>
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</tr>
<tr>
<td>Dar et al. (2005)</td>
<td>Within-subjects design: assessed 3 times of smoking availability (workday regular smoking vs. Sabbath no smoking vs. workday no smoking)</td>
<td>Smokers abstained for 24 hrs for 1 session.</td>
<td>N = 20, mean age = 28.5 years old, mean CPD = 12.1</td>
</tr>
<tr>
<td>Dar et al. (2010)</td>
<td>Within-subjects design: examined craving levels among flight attendants who were not permitted to smoke. On two-way flight comprising two short legs (3-5.5 hrs each leg) with a 1-hr intermission and long, one-way flight (8-13 hrs).</td>
<td></td>
<td>N = 53, mean age = 28.5 years old, mean CPD = 12.1</td>
</tr>
</tbody>
</table>

**Objectives and Study Design**

As addressed in the research above, it is well-supported that a smoker’s urge increases when smoking is expected to take place sooner than later. Further, research demonstrates smoking-related stimuli increases urge to smoke. While a number of studies have manipulated two different availability time points, only Ross & Juliano (2015) examined more than two time-points. To test the linearity of the relationship, a third time point must be used. Furthermore, with the exception of Ross & Juliano (2015), prior studies have all manipulated availability within a relatively short time window, with a maximum delay of 4 hours. Thus, it is unknown what effect
availability has on smoking motivation with extended delays. As naturalistic conditions arise (i.e., work days, air travel, running out of cigarettes) and contexts limiting cigarette use become more popular (i.e., smoke-free parks, beaches), it is important to assess immediate reactions to the expectation that smoking will be unavailable for an extended period of time.

A limitation of Ross & Juliano (2015) is that all subjects were exposed to smoking-related stimuli. Thus, the independent effects of availability and/or interactions with stimuli could not be ascertained. The current study was designed to replicate and extend Ross & Juliano (2015) by manipulating both availability and exposure to environmental stimuli.

Using a 3 X 2 between-subjects factorial design this study manipulated smoking availability (20 mins vs. 3 hrs vs. 24 hrs) and smoking stimuli (smoking-related vs neutral stimuli) to test the independent and interactive effects of availability and stimuli on smoking motivation. Measures of smoking motivation included self-reported urge, mood, and withdrawal symptoms. In addition, a simple auditory reaction time measure was included based on the idea that delays in reaction time reflect cognitive interference resulting from drug urge (Cepeda-Benito & Tiffany, 1996; Juliano & Brandon, 1998; Ross & Juliano, 2015; Sayette & Hufford, 1994; Tiffany, 1990). This study also employed a smoking choice procedure to determine if the manipulations had any subsequent effect on actual smoking behavior. This is a novel addition to the current literature, as only one (Droungas et al., 1995) study has examined smoking availability, cue reactivity, and smoking behavior in the same research design.

Hypotheses

As discussed prior, different theories of addiction inform different predictions about the relationship between availability and smoking motivation. The theory of conditioned withdrawal posits that cues associated with withdrawal (i.e., the inability to smoke for 24 hours) may elicit withdrawal reactions, thus increasing one’s motivation to smoke (Wikler, 1973). Reactance
theory also suggests that urge will increase as restriction of smoking increases (e.g., 24 hrs) (Brehm & Brehm, 1981). Prior research has shown that urge increases when smoking is available soon and decreases when smoking is unavailable for 1-3 hours, yet when drugs become unavailable for extended periods of time (i.e., 24 hrs), Wikler’s theory would suggest that urge would increase. Tiffany’s (1990) cognitive theory suggests that smoking unavailability of 3 hours could be within a person’s drug use schema (i.e. not being able to smoke during a movie or long meeting), but when smoking unavailability extends to 24 hours, the length of non-smoking may interfere with their typical drug use schema and result in greater urge. Together, this evidence would hypothesize a non-linear relationship between smoking availability and self-reported urge and withdrawal, such that the 20 minute and 24 hour conditions would have significantly higher average urge and withdrawal ratings than the 3 hour availability condition.

Other theories make predictions about smoking availability and mood. Ross and Juliano (2015) found that the direction of the relationship between positive affect and urge was non-significantly positive in the most available condition (i.e., 20 mins) and significantly negative in the least available condition (i.e., 24 hrs), which is consistent with prior studies (Bailey et al., 2010; Carter & Tiffany, 2001). This pattern of findings is also consistent with Baker et al.’s (1987) model. Thus, taken together, it was hypothesized that there would be a linear relationship between smoking availability and mood, such that positive mood will decrease and negative mood will increase as the expected delay before smoking increases.

Some theories make predictions about the relationship between urge and reaction time under different conditions of availability. Tiffany’s (1990) model of drug urges is supported in the literature, as a number of studies have identified significant correlations between urge and reaction time (Cepeda-Benito & Tiffany, 1996; Sayette & Hufford, 1994). Since we predicted that there would be a non-linear relationship between availability and urge, and urge and reaction
time (i.e., cognitive interference) are related, the relationship between smoking availability and reaction time should follow the same pattern. Thus, it was predicted that the 20 minute and 24 hour conditions would have significantly greater interference in their reaction times (i.e., slower times) than the 3-hour condition.

This study also examined how smoking availability impacts the relationships between environmental stimuli and urge, mood, withdrawal, and reaction time. Previous studies have shown that smoking-related stimuli increase urge to smoke and reaction time compared to neutral stimuli among smokers (Bailey et al., 2010; Carter & Tiffany, 2001; Juliano & Brandon, 1998; Wertz & Sayette, 2001a). Thus, it was hypothesized that smoking availability would moderate reactions to smoking-related cues.

Lastly, the smoking choice task was used to explore how differences in smoking availability and exposure to environmental stimuli contribute to latency to smoke post-manipulation. There is limited research in this area to provide a theoretical basis for hypotheses. Bold, Yoon, Chapman, and McCarthy (2013) used a similar choice task and found that greater pre-task craving predicted smoking sooner in the task, and Mitchell (2004) found that, for smokers abstaining from cigarettes for 24 hours, the number of cigarette choices increased on all three smoking choice tasks. Despite these findings, data from this choice task will provide exploratory findings on whether or not participants engaged in smoking behavior and how soon or delayed it was when they initiated smoking.
CHAPTER 2

METHODS

Participants

Participants were recruited from the American University campus and local Washington DC. area through flyers, web postings (i.e., Craigslist and American University Psychology Research page), and newspaper advertisements (i.e., Express paper). (See Appendix C) There were a total of 633 responses to recruitment efforts, and of those, 380 individuals were screened for eligibility for the study (see Figure 1 for a recruitment and enrollment consort diagram). Eligibility criteria included being aged 18 to 65 and smoking at least 5 cigarettes per day, every day, for at least one year. Participants could not currently use nicotine replacement therapy (i.e., nicotine patch, gum, lozenge, spray), Wellbutrin or Chantix, marijuana or other nicotine products (or be willing to abstain for the duration of the study) or have chronic smoking-related health problems. Participants should be able to read printed materials in English and be able to use a computer (i.e., can click on a mouse and press the spacebar). Women who indicated that they were pregnant or might be pregnant were not eligible. Power analysis revealed that 192 participants (32/condition) would provide adequate power (minimum .80) based on the small to medium effects observed in prior studies with alpha set at $p < .05$.

Of those screened, 294 were eligible and 181 participants were enrolled and randomized into the study. The 113 individuals who were screened but not enrolled in the study were not able to be reached by phone or email after the initial contact. One participant dropped immediately after the manipulation and stated that he did not want to abstain from smoking for 24 hours. Thus, the final sample was comprised of 180 participants (38% female) randomized to 6 experimental groups. Participants smoked a mean of 11.5 cigarettes per day (SD 5.64) for 16.2 years (SD 12.77) and had a mean breath carbon monoxide level of 10.8 ppm (SD 8.45) after 2-hr
of smoking abstinence. Demographic information is shown in Table 2. This study was approved by the American University (AU) Institutional Review Board.

**Table 2. Demographic Information**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Percent (% of participants)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>62.2%</td>
</tr>
<tr>
<td>Female</td>
<td>37.8%</td>
</tr>
<tr>
<td>Age (in years)</td>
<td>37.64 (SD=14.48)</td>
</tr>
<tr>
<td>Race</td>
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<tr>
<td>African American</td>
<td>60.0%</td>
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<tr>
<td>Caucasian</td>
<td>31.7%</td>
</tr>
<tr>
<td>Asian</td>
<td>2.8%</td>
</tr>
<tr>
<td>Mixed</td>
<td>2.2%</td>
</tr>
<tr>
<td>Other</td>
<td>3.3%</td>
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<tr>
<td>Hispanic</td>
<td>7.2%</td>
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<tr>
<td>Marital Status</td>
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<tr>
<td>Single</td>
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<td>Married</td>
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<td>Divorced</td>
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<tr>
<td>Other</td>
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<tr>
<td>Highest Level of Education</td>
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<tr>
<td>Middle school</td>
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<tr>
<td>High school</td>
<td>25.6%</td>
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<tr>
<td>Vocational school</td>
<td>12.2%</td>
</tr>
<tr>
<td>Some college</td>
<td>48.9%</td>
</tr>
<tr>
<td>4-year college degree</td>
<td>4.4%</td>
</tr>
<tr>
<td>Some post-graduate work</td>
<td>3.3%</td>
</tr>
<tr>
<td>Post-graduate degree</td>
<td>4.4%</td>
</tr>
<tr>
<td>Employment</td>
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</tr>
<tr>
<td>Unemployed</td>
<td>37.8%</td>
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<tr>
<td>Part-time</td>
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<tr>
<td>Full-time</td>
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</tr>
<tr>
<td>Disability</td>
<td>14.4%</td>
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<tr>
<td>Retired</td>
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</tr>
<tr>
<td>Student status</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Full-time</td>
<td>26.1%</td>
</tr>
<tr>
<td>Part-time</td>
<td>6.1%</td>
</tr>
<tr>
<td>Not a student</td>
<td>67.8%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Income</th>
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</thead>
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<tr>
<td>Less than $10,000</td>
<td>29.4%</td>
</tr>
<tr>
<td>$10,000-$19,999</td>
<td>16.1%</td>
</tr>
<tr>
<td>$20,000-$29,999</td>
<td>12.8%</td>
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<tr>
<td>$30,000-$39,999</td>
<td>6.7%</td>
</tr>
<tr>
<td>$40,000-$49,999</td>
<td>6.7%</td>
</tr>
<tr>
<td>$50,000-$59,999</td>
<td>5.0%</td>
</tr>
<tr>
<td>$60,000-$69,999</td>
<td>2.8%</td>
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<tr>
<td>$70,000-$79,999</td>
<td>5.6%</td>
</tr>
<tr>
<td>$80,000-$89,999</td>
<td>2.8%</td>
</tr>
<tr>
<td>$90,000-$99,999</td>
<td>2.8%</td>
</tr>
<tr>
<td>$100,000 +</td>
<td>9.4%</td>
</tr>
</tbody>
</table>
Figure 1. Recruitment and Enrollment Consort Diagram.
Measures

*Alveolar carbon monoxide breath sample (CO).* Breath samples were obtained using a Bedfont Micro+ Smokerlyzer Device (Kent, U.K.). Carbon monoxide readings were collected to determine recent smoking exposure and encourage compliance with the two hours of abstinence required before the first session. It was also employed as a “bogus pipeline” procedure to create the expectation that we would be able to detect if participants did not comply with the abstinence instructions in the 24-hour abstinence conditions (Aguinis & Handelsman, 1997).

*Smoking History and Demographics Questionnaire.* This questionnaire, developed by our laboratory, contains 9 demographic information questions, as well as 20 smoking history questions (i.e., last quit attempt, cigarette preference, smoking exposure, etc.), and 2 questions about alcohol use. (See Appendix B)

*Fagerström Test for Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991).* This is a widely used 6-item measure of nicotine dependence that yields a total score between 0 and 10. Low dependence is characterized by a score of 1-2, low to moderate dependence by a score of 3-4, moderate dependence by a score of 5-7, and high dependence by a score of 8 or higher. Results from this study found an internal consistency of .660, which is not particularly strong, but consistent with many previous studies that reported modest internal consistency for the FTND (Burling & Burling, 2003; Heatherton et al., 1991; Payne, Smith, McCracken, McSherry, & Antony, 1994; Pomerleau, Carton, Lutzke, Flessland, & Pomerleau, 1994; Steinberg, Williams, Steinberg, Krejci, & Ziedonis, 2005). (See Appendix B)

*Smoking Consequences Questionnaire- Adult (SCQ-A; Copeland, Brandon, & Quinn, 1995).* This 55-item measure assesses beliefs people have about the consequences of smoking and was administered at baseline. Each item is rated on a scale from 0 = completely unlikely to 9 = completely likely. The measure has 10 factors: Negative Affect Reduction, Stimulation/State
Enhancement, Health Risk, Taste/Sensorimotor Manipulation, Social Facilitation, Appetite/Weight Control, Craving/Addiction, Negative Physical Feelings, Boredom Reduction, Negative Social Impression. Copeland et al. (1995) found that all scales on the SCQ-A show good internal consistency reliability, with a mean of 0.87 coefficient reliability. The present study found similar internal consistency values, indicated as follows: Negative Affect Reduction = .924, Appetite/Weight Control = .914, Taste/Sensorimotor Manipulation = .888, Health Risk = .874, Stimulation/State Enhancement = .848, Social Facilitation = .845, Boredom Reduction = .842, Craving/Addiction = .753, Negative Social Impression = .697, Negative Physical Feelings = .688. (See Appendix B)

**Kirby Monetary Choice Questionnaire.** This measure is used to determine equivalent levels of impulsivity and delay discounting across our groups at baseline. Participants are presented with 27 items where they must select which monetary reward they would prefer (i.e., a certain amount of money available today vs. a certain amount of money available after a certain amount of days). Coefficient alpha reliability in the present study was .898. Kirby (2009) found adequate temporal stability among 100 undergraduate students who completed the questionnaire at baseline, 5-weeks post- (0.77; 95% confidence interval = 0.67-0.85), 1-year post- (0.71; 0.50-0.84), and 57-weeks post-baseline (0.63; 0.41-0.77). They found that the 1-year and 57-week test-retest reliabilities compare favorably with the 1-year test-retest stabilities of several personality scales, which suggests that the discount rate for monetary rewards is a stable individual difference (Kirby, 2009). In addition, Kirby, Petry, and Bickel (1999) found that correlations between self-reported impulsivity and delayed discounting (Kirby’s k) were reliable, $p < 0.5$ (unadjusted). (See Appendix B)

**Contemplation Ladder (Biener & Abrams, 1991).** Participants rated their current readiness to quit smoking using an 11-item scale ranging from 0 = No thought of quitting to 10 = Taking
action to quit, e.g., cutting down, enrolling in a program. This measure has been found to predict the likelihood of a quit attempt in the next 6 months (Biener & Abrams, 1991). (See Appendix B)

**Urge Rating Scale (Kozlowski, Pillitteri, Sweeney, Whitefield, & Graham, 1996).** Participants completed this 3-item measure that assesses desire, want, and craving for a cigarette. Each item was rated on a 100-point scale from 0 = not at all to 100 = greatest ever experienced (Juliano & Brandon, 1998; Ross & Juliano, 2015; Sayette, Loewenstein, Kirchner, & Travis, 2005). For each time-point where urge was assessed, a mean urge score was created by averaging the 3 urge items. The mean internal consistency was .974. (See Appendix B)

**Diener & Emmons Positive and Negative Affect Scale (Diener & Emmons, 1984).** This scale listed 4 positive (‘happy’, ‘joyful’, ‘pleased’, ‘enjoyment/fun’) and 5 negative (‘depressed/blue’, ‘unhappy’, ‘frustrated’, ‘worry’, ‘angry/hostile’) emotions that participants rated from 0 = not at all to 6 = extremely much. For each 4 time-points where mood was assessed, a mean positive mood score was produced by averaging the 4 positive mood items, and a mean negative mood score was created by averaging the 5 negative mood items. The mean internal consistency was .914 for positive mood and .909 for negative mood. Diener and Emmons (1984) found that the strongest ($r = -0.85$) and smallest ($r = -0.10$) negative correlations between positive and negative affect were unlikely to allow an individual to feel both affects at the same time, even at strong levels. (See Appendix B)

**Minnesota Nicotine Withdrawal Scale- Revised (MNWS).** This measure was given to examine baseline level of nicotine withdrawal, as well as potential change in withdrawal symptoms following the manipulations. Participants completed 5-items assessing DSM-5 withdrawal symptoms (i.e., anger/irritability/frustration, anxiety/nervousness, depressed mood/sad, difficulty concentrating, restlessness) that were rated from 0 = not at all to 6 = extremely much. Due to the
short duration of the study, items assessing insomnia and increased appetite were not included from the full measure. An overall withdrawal score was created by averaging the five individual items. This measure has shown adequate test-retest reliability (0.64) and strong internal consistency (0.90) (Weinberger et. al, 2007). In this study, the mean internal consistency was .907. (See Appendix B)

**Auditory Simple Reaction Time Task.** Participants were instructed to press the spacebar on a keyboard as quickly as possible in response to a series of tones (72 dB, 600 Hz, 250 ms duration, with inter-stimulus intervals averaging 20 seconds; Juliano & Brandon, 1998; Ross & Juliano, 2015) controlled by a computer and presented through speakers. DirectRT was used to record response latencies for each participant. Participants completed practice sessions consisting of four trials and then completed an experimental session, consisting of six trials, before and after the smoking availability manipulation. To account for outliers, scores greater than 1500ms were trimmed to 1500ms as the greatest value possible for this item. Consistent with prior research, only the mean of the first 2 reaction time trials were used in the analyses (Cepeda-Benito & Tiffany, 1996; Juliano & Brandon, 1998; Ross & Juliano, 2015; Sayette & Hufford, 1994). The mean internal consistency in the current study was .930. (See Appendix B)

**Manipulation Check Measure.** This 5-item measure was used to assess if participants in each group intended to follow the smoking availability instructions (Ross & Juliano, 2015). The questionnaire asked participants how difficult it would be for them to follow the smoking instructions and how much they intended to follow them; both were rated on a 7-point scale. Confidence in remaining abstinent for the given smoking instructions and confidence in remaining abstinent for 24 hours were also assessed using a 7-point scale (1 = not confident at all to 7 = extremely confident). Lastly, participants were asked to share any reactions they had to the information they were given about when they could smoke. (See Appendix D)
**Experiment Evaluation.** This measure was given to obtain feedback about participants’ experiences in the study, as well as to determine if the participants recognized any deception in the experiment. Ten questions were asked including general questions assessing if they enjoyed the study, found it interesting, learned anything, etc., as well as questions assessing the efficacy of the deception (i.e., more to the study than meets the eye, felt deceived during study, etc.) (See Appendix D)

**Procedure**

Participants completed a phone screen and eligibility was assessed. During scheduling participants were informed that the experiment required two laboratory visits, scheduled 24 hours apart and would pay $45 plus up to a $5 bonus. This was done so that participants in the 24 hours conditions would believe that they would have to come back to the lab to assess if they had followed the abstinence instructions. They were told that they would be asked to provide a carbon monoxide reading to verify their smoking status, as well as complete questionnaires and computer tasks in the laboratory. Participants were instructed to bring their preferred cigarettes to the first session and abstain from all nicotine and marijuana use for 2 hours before their appointment time. The abstinence requirement was included to control for last nicotine exposure (Payne, Smith, Sturges, & Holleran, 1996; Juliano & Brandon, 1998; Ross & Juliano, 2015). They were not given any information about whether or not they would be permitted to smoke during the study.

**Experimental Session**

Upon arrival, participants were greeted by the experimenter and led to a room that contained a desk, two chairs, a computer with speakers, and a smoking ventilation fan. During informed consent, participants were reminded that the session could last for up to three hours, participation may involve smoking abstinence, and a brief follow-up session would be scheduled
for the next day. The experimenter obtained the participant's cigarettes. Participants reported when they last smoked and a carbon monoxide breath sample was taken. There was a box, positioned on the desk and next to the computer, that blocked the view of the experimental stimuli. If randomized to the neutral stimuli conditions, this box blocked exposure to the stapler, tape, and pens; but, if randomized to the smoking stimuli conditions, this box blocked exposure to the ashtray and lighter. Baseline measures included the Smoking History and Demographics Questionnaire, SCQ-A, Contemplation Ladder, FTND, Kirby Questionnaire, Urge Ratings Scale, Diener & Emmons Mood Scale, and MNWS. While participants were filling out questionnaires, if randomized to be exposed to smoking stimuli, the experimenter discretely placed the participants’ pack of cigarettes with an ashtray and lighter located behind a box blocking their view. If participants were randomized to the neutral stimuli conditions, the experimenter took their pack of cigarettes outside of the room. After completing the baseline measures participants performed 2 practice trials of the simple reaction time task, followed by 6 baseline trials. Afterwards the experimenter returned to the room and delivered one of six manipulations based on random assignment:

1. Groups 1 and 4 (Smoking Available in 20 minutes). Participants assigned to these groups were told: “Today’s session will last for up to 3 hours. As mentioned earlier, you will be asked to come back in 24 hours for a brief assessment, which will include providing a breath sample to indicate your carbon monoxide levels, which tells us if you have recently smoked. You will have a break sometime in the next 20 minutes, during which you will have an opportunity to smoke a cigarette. During this break, you can smoke in the laboratory room or you can choose to go outside in the courtyard if you would like.”

2. Groups 2 and 5 (Smoking Available in 3 hours). Participants assigned to these groups were told: “Today’s session will last for up to 3 hours. As mentioned earlier, you will be asked to come back in 24 hours for a brief assessment, which will include providing a breath sample to indicate your carbon monoxide levels, which tells us if you have recently smoked. You will have a break sometime in the next 20 minutes. During this break, you can stay in the laboratory room or you can go outside in the courtyard if you
would like. You will NOT be able to smoke during this break, but you will be able to smoke at the end of this 3-hour session.”

3. Groups 3 and 6 (Smoking Available in 24 hours). Participants assigned to these groups were told: “Today’s session will last for up to 3 hours. You will not be permitted to smoke at all during the session today or for the next 24 hours. As mentioned earlier, you will be asked to come back in 24 hours for a brief assessment, which will include providing a breath sample to indicate your carbon monoxide levels, which tells us if you have recently smoked. You will have a break sometime in the next 20 minutes. During this break, you can stay in the laboratory room or you can go outside in the courtyard if you would like. You will NOT be able to smoke during this break and we will also ask that you do not smoke for the next 24 hours. So, your next opportunity to smoke will be at tomorrow’s session.”

After the experimenter delivered the availability manipulation and began loading the next set of questionnaires on the computer, they surreptitiously removed a box that held the carbon monoxide monitor, which now clearly exposed either the smoking-related stimuli (i.e., the participant's pack of cigarettes, ashtray, and lighter) or neutral stimuli (i.e., pens, tape, stapler). Similar to Ross & Juliano (2015), this procedure was used to reduce the potential reactivity that may occur if the experimenter were to physically place down the stimuli while concurrently telling the participant they will not be permitted to smoke (Juliano & Brandon, 1998).

Participants then completed post-manipulation measures of mood, urge, and withdrawal and another round of 2 practice trials and 6 post-manipulation trials of the simple reaction time task.

After they completed these measures and tasks the experimenter told participants that they were experiencing computer problems. Experimenters left the participants in the study room and pretended to fix the computer in the other laboratory room for about 5 minutes, with the hope that this increase credibility of the manipulation. After failed attempts to fix the computer program, participants were told that they would complete all assessments scheduled for the next day during the present visit, thus eliminating the need to return. All participants were told that they would complete a few brief questionnaires and then would be given an opportunity to
smoke a cigarette in the laboratory. They completed post-manipulation measures of urge, mood, and withdrawal. Then, in the neutral stimuli conditions the experimenter brought the participant’s pack of cigarettes and an ashtray and lighter into the room. These stimuli were already present for those in the smoking stimuli conditions. Participants were then told that they would have a choice to smoke or earn $0.50 for every 5-minute block of time that they delayed smoking. A phone placed in the room was programmed to make a sound every 5 minutes for a total of 50 minutes. Participants were not told how long the choice period would be and were not permitted to sleep, read, or use their cell phones during the task (i.e., no distractions). Latency to smoke was recorded as well as number of puffs taken, and smoking duration.

After the participants smoked or the 50-minute waiting period ended, participants completed a final set of measures assessing urge, mood, withdrawal, as well as a Debriefing Questionnaire and Experiment Evaluation Form (see Appendix D). Experimenters read a debriefing script that explained that the purpose of the study was to determine if beliefs about when they could smoke affected their urge, mood, and reaction time. Participants were informed that because the experiment was only interested in the effects of the belief, it was not necessary to actually abstain from smoking, or to have a follow-up appointment the following day. Experimenters also asked participants not to share this information with any potential participants, as this could contaminate their data. (See Appendix E). Lastly, participants were compensated for their time and cigarettes were returned. The entire session took about 1.5 to 2.5 hours to complete. See Figure 2 for full study flow chart.
Figure 2. Study Flow Chart.
CHAPTER 3

RESULTS

Data Analytic Strategy

The main outcome of interest was the immediate effects of the manipulations on urge, withdrawal, mood, and reaction time. A series of 3 (Availability) X 2 (Stimuli) ANCOVA’s were run for each of the dependent variables with the pre-manipulation score entered as covariate. Pairwise comparisons among the cell means were conducted using Fisher’s LSD tests. The ANCOVA approach reduces potential biased estimates that could be introduced by creating pre to post difference scores. However, it should be noted that results do not differ when difference scores are analyzed with ANOVA. The results reported herein are also entirely consistent with findings using 2 (Time) X 3 (Availability) X 2 (Stimuli) mixed design ANOVAs, which was not presented for ease of interpretation.

Cox Proportional Hazards models were run to examine latency to smoke (with data censored at 50 mins) during the smoking choice procedure.

Baseline Data

A series of 3 (Availability) X 2 (Stimuli) Analysis of Variance (ANOVAs) were conducted to assess for any potential baseline differences across groups on baseline and dependent variables. No significant baseline differences were observed (see Table 3).

Table 3. Baseline Values Across the Experimental Groups

<table>
<thead>
<tr>
<th></th>
<th>Neutral/20 mins $M (SD)$</th>
<th>Smoking/20 mins $M (SD)$</th>
<th>Neutral/3 hrs $M (SD)$</th>
<th>Smoking/3 hrs $M (SD)$</th>
<th>Neutral/24 hrs $M (SD)$</th>
<th>Smoking/24 hrs $M (SD)$</th>
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<tr>
<td>Cigarettes Per Day</td>
<td>12.12 (5.95)</td>
<td>12.47 (7.20)</td>
<td>11.23 (6.13)</td>
<td>11.63 (4.97)</td>
<td>10.78 (4.77)</td>
<td>10.73 (4.65)</td>
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<tr>
<td>Years Smoked</td>
<td>17.07 (12.80)</td>
<td>14.05 (10.40)</td>
<td>18.35 (14.95)</td>
<td>17.02 (13.25)</td>
<td>16.15 (11.96)</td>
<td>14.57 (13.34)</td>
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<tr>
<td>Total FTND</td>
<td>4.03 (2.51)</td>
<td>4.53 (2.60)</td>
<td>3.90 (2.41)</td>
<td>4.23 (1.87)</td>
<td>3.93 (2.43)</td>
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### Last Cigarette (hrs)

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<td>(hours)</td>
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<td>(1.89)</td>
<td>(0.44)</td>
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### CO Level (ppm)

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### Baseline Positive Mood

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### Baseline Negative Mood

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### Baseline Withdrawal

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<tbody>
<tr>
<td>(ppm)</td>
<td>(1.63)</td>
<td>(1.77)</td>
<td>(1.27)</td>
<td>(1.50)</td>
<td>(1.44)</td>
<td>(1.64)</td>
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### Baseline Reaction Time

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<tr>
<th></th>
<th>428.62</th>
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<th>428.88</th>
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<tbody>
<tr>
<td>(ppm)</td>
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<td>(156.36)</td>
<td>(155.08)</td>
<td>(212.32)</td>
<td>(133.67)</td>
<td>(216.09)</td>
</tr>
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</table>

**Note.** FTND = Fagerstrom Test of Nicotine Dependence, ppm = parts per million.

### Main Analyses

**Urge**

For smoking urge there were no main effects of availability, $F(2, 173) = .038, p = .963,$ partial $\eta^2 = .000$ or environmental stimuli, $F(1, 173) = .419, p = .518,$ partial $\eta^2 = .002,$ and no stimuli by availability interactions, $F(2, 173) = 2.063, p = .130,$ partial $\eta^2 = .023$ (see Figure 3).

![Figure 3](image-url) **Figure 3.** Post-Manipulation Covariate Adjusted Means for Urge.
Withdrawal

There was a main effect of the availability manipulation on withdrawal, $F(2,173) = 5.414$, $p = .005$, partial $\eta^2 = .059$. Fisher’s LSD comparisons revealed that individuals who were told 24 hrs ($M = 2.13$) reported significantly greater withdrawal than the 20 mins ($M = 1.82$) group ($p = .030$, 95% CI [0.03, 0.59]) and 3 hrs ($M = 1.67$) group ($p = .002$, 95% CI [0.18, 0.74]). There was no main effect of stimuli $F(1, 173) = 0.304$, $p = .582$, partial $\eta^2 = .002$, and no stimuli by availability interaction, $F(2, 173) = 2.653$, $p = .073$, partial $\eta^2 = .030$. See Figure 4.

![Figure 4](image_url)

*Figure 4. Post-Manipulation Covariate Adjusted Means for Withdrawal.*

Mood

There was a main effect of the availability manipulation on negative mood, $F(2,173) = 8.725$, $p < .001$, partial $\eta^2 = .092$. Pairwise comparisons revealed that individuals who were told 24 hrs ($M = 1.98$) had significantly greater negative mood than the 20 mins ($M = 1.56$) group ($p = .006$, 95% CI [0.12, 0.72]) and 3 hrs ($M = 1.35$) group ($p < .001$, 95% CI [0.32, 0.92]). There was no main effect of stimuli, $F(1, 173) = 0.660$, $p = .418$, partial $\eta^2 = .004$, and no stimuli by availability interaction, $F(2, 173) = 1.814$, $p = .166$, partial $\eta^2 = .021$. See Figure 5.
For positive mood there were no effects of availability, $F(2, 173) = 1.881, p = .156$, partial $\eta^2 = .021$, no effects of stimuli, $F(1, 173) = .123, p = .726$, partial $\eta^2 = .001$ and no stimuli by availability interactions, $F(2, 173) = 1.131, p = .325$, partial $\eta^2 = .013$. See Figure 6.

**Figure 5.** Post-Manipulation Covariate Adjusted Means for Negative Mood.

**Figure 6.** Post-Manipulation Covariate Adjusted Means for Positive Mood.
Reaction Time

For reaction time there were no main effects of availability, $F(2, 173) = 2.457, p = .089$, partial $\eta^2 = .028$, no effects of stimuli, $F(1, 173) = .142, p = .707$, partial $\eta^2 = .001$ and no stimuli by availability interaction, $F(2, 173) = 1.110, p = .332$, partial $\eta^2 = .013$. See Figure 7.

![Reaction Time Graph](image)

Figure 7. Post-Manipulation Covariate Adjusted Means for Reaction Time.

Smoking Choice Procedure

Nearly 70% of participants chose to smoke during the smoking choice procedure and the latency to smoke varied. Cox Proportional Hazards models were run to examine the effects of the prior manipulations on latency to smoke (with data censored at 50 minutes). By this time, all participants were in the presence of smoking stimuli and were instructed that smoking was available should they choose to smoke. As seen in Figure 8, participants who were just now exposed to smoking stimuli were significantly more likely to smoke than who had been exposed to smoking stimuli prior during the session ($Wald = 6.05, HR = 1.56$ (CI:1.10-2.25); $p = .014$; mean of 18.0 vs. 25.94 minutes). Participants delayed smoking for a mean of 18.75, 21.33, and
25.83 minutes in the 20 minutes, 3 hours, and 24 hours conditions, respectively but the effect of availability was not significant \( (\text{Wald} = 2.48, HR = 1.42 \ (\text{CI}:1.09-2.23); p = .115) \). See Figure 9.

When examining the relationships among the dependent variables and latency to smoke, a significant positive correlation was found between latency to smoke and positive mood \( r(178) = .157, p = 0.035 \). Significant negative correlations were found between latency to smoke and urge \( r(178) = -.268, p < 0.001 \), negative mood \( r(178) = -.150, p = 0.045 \), and withdrawal \( r(178) = -.183, p = 0.014 \). See Table 4.

![Figure 8. The Effect of Stimuli on Latency to Smoke.](image-url)
Figure 9. The Effect of Availability on Latency to Smoke.

Table 4. Correlations among Dependent Variables and Time to Smoke

<table>
<thead>
<tr>
<th></th>
<th>Withdrawal</th>
<th>Urge</th>
<th>Positive Mood</th>
<th>Negative Mood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to Smoke</td>
<td>-0.183*</td>
<td>-0.268**</td>
<td>0.157*</td>
<td>-0.150*</td>
</tr>
</tbody>
</table>

Note: * p < 0.05. ** p < 0.01

End of Study Debriefing

All participants were administered a debriefing questionnaire and experiment evaluation form (see Appendix D). Descriptive analyses were run to determine whether participants believed and intended to follow study procedures. As seen in Table 5, participants endorsed high levels of intent to follow study instructions about smoking (i.e., based on their randomized availability condition) and confidence in their ability to do so. They also reported low levels of feeling like it would be difficult to follow instructions about when they could smoke, suggesting that they would have obliged with their study condition instruction. Further, participants endorsed low levels of dislike about the study and of feeling deceived in the study, indicating
that the study manipulations were effective and believable. Participants reported a moderate level of “feeling like there is more to the study than meets the eye”, but upon inspection of their self-report, many participants could not identify anything specific. There were no significant between-group differences found on either of these questions.

Table 5. Debriefing and Experimental Evaluation Descriptive Information

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficulty following instructions about smoking</td>
<td>3.73</td>
<td>2.201</td>
</tr>
<tr>
<td>Intend to follow instructions about smoking</td>
<td>6.37</td>
<td>1.316</td>
</tr>
<tr>
<td>Confident in abstaining from smoking until permitted</td>
<td>5.99</td>
<td>1.521</td>
</tr>
<tr>
<td>Confident in abstaining for 24 hours</td>
<td>4.82</td>
<td>2.004</td>
</tr>
<tr>
<td>More to study than meets the eye</td>
<td>0.57</td>
<td>0.496</td>
</tr>
<tr>
<td>Anything disliked about study</td>
<td>0.20</td>
<td>0.401</td>
</tr>
<tr>
<td>Feel deceived in study</td>
<td>0.22</td>
<td>0.417</td>
</tr>
</tbody>
</table>

*Note.* 1-4 scored 1-7, 5-7 scored 0-1.
CHAPTER 4
DISCUSSION

This laboratory-based study tested the effect of smoking availability and smoking-related stimuli on smoking motivation using a between-subjects factorial design. This is the first study to manipulate three times points of availability (20 mins vs. 3 hrs vs. 24 hrs) while also varying smoking-related environmental stimuli. Dependent measures included urge, withdrawal, mood and simple reaction time. After this portion of the experiment was over, participants were given an opportunity to smoke or earn money using a validated 50-minute smoking choice procedure and latency to smoke was recorded.

Contrary to prior findings, there were no significant effects of availability or stimuli on self-reported urge to smoke. Droungas et al. (1995) found that after a cue exposure session, subjects who thought that smoking was available soon reported greater desire to smoke when presented with smoking-related stimuli as compared to baseline, and also reported greater desire to smoke when exposed to smoking-related cues than to neutral cues. Juliano & Brandon (1998) found that subjects who were instructed that smoking would be available soon (i.e., 20 minutes) reported stronger urges than those who were instructed that smoking would not be available for 3 hours. Further, they found that smoking availability instructions interacted with reactivity to smoking-related stimuli such that smokers told that smoking would be available soon showed increases in urge when exposed to smoking-related stimuli. Furthermore, Sayette and colleagues (2003) observed greater urges among participants in cue exposure sessions when they believed that smoking would take place or when the expected delays before smoking were shorter (i.e., 15sec>30sec>60sec). Carter and Tiffany (2001) found the smokers exposed to a lit cigarette or a cup of water while being told that there is a 0%, 50%, or 100% chance of consuming the cue display increased craving ratings in the presence of the cigarette as a function of the increasing
probability of smoking, with the greatest differences between cigarette and water cues when smoking was 100% probable. Finally, studies manipulating smoking availability by exposing smokers to stimuli that signal smoking (CS+) or not smoking (CS−) observed greater urges when smoking was expected versus when it was not, especially when smoking stimuli were present (Dols, Willems, van den Hout, & Bittoun, 2000; 2002) and when there was an awareness of the contingency between the stimuli and smoking (Field & Duka, 2001, Lazev et al., 1999).

There are several studies that found no effects of availability or stimuli on urge (Field & Duka, 2004; Sayette & Hufford, 1995; Wertz & Sayette, 2001a). The study we attempted to replicate (Ross & Juliano, 2015) also found no significant differences for urge across the same 3 time points of smoking availability. In that study, ceiling effects on the urge measure were noted and may have limited the possible range of change scores, as all three levels of manipulation were designed to increase urge to some extent (Ross & Juliano, 2015). In the present study, the urge measure was modified to prevent ceiling effects. The modification appeared to be successful in this regard as the mean score on the 100-point scale was 58.73. However, we also did not observe effects on urge. It is important to note that if the 24 hr condition is removed, an almost significant main effect is found for stimuli ($p = .072$) among the 20 mins and 3 hr groups, such that those exposed to smoking-related stimuli reported greater urge than those exposed to neutral stimuli. This finding would be consistent with many other studies (Carter & Tiffany, 2001; Dols et al., 2000, 2002; Droungas et al., 1995; Juliano & Brandon, 1998). While including the 24 hr condition in our analyses created a near interaction between smoking availability and stimuli for urge ($p = .13$), this marginally significant main effect is obscured.

There were no main effects of smoking-related stimuli on urge, mood, withdrawal, or reaction time. This finding is important to consider within the larger context of cue reactivity research, which examines how different conditioned stimuli (CSs) produce conditioned
responses (CRs) that prompt drug use. Part of this research focuses on identifying specific types of stimuli that cause CRs in the laboratory. As such, environmental stimuli comprise a category of stimuli that have been rigorously tested in the laboratory. For example, smoking-related cues (e.g., cigarettes, lighters, ashtrays) have been found to elicit greater urge to smoke, withdrawal, and changes in mood than do neutral cues (Carter & Tiffany, 2001; Dols et al., 2000; 2002; Juliano & Brandon, 1998; Wertz & Sayette, 2001a). Studies have varied their approach to presenting cues, as some have placed the cues directly on the participants’ desk while others have hid cues behind boxes or other objects before exposing them to participants. Some studies instructed participants to pick up, hold, or even light the cigarette during cue exposure, whereas others simply had subjects view the cues. Other studies have examined cue reactivity by using drug-related imagery as stimuli when assessing outcomes and found that they have powerful effects (Tiffany & Drobes, 1990). As a result, it was expected that, in this study, exposure to smoking-related stimuli would have elicited strong reactions to outcome variables than when exposed to neutral stimuli. However, the opposite was found. This could be because of the way the stimuli were presented to participants. Other studies that used drug-related imagery (Conklin et al., 2015; Payne et al., 1991; Tiffany & Drobes, 1990) or instructed participants to hold or light cigarette cues (Carter & Tiffany, 2001; Droungas et al., 1995; Wilson et al., 2005) elicited strong effects for stimuli; therefore, it is possible that simply hiding and exposing cues on a desk did not have the same powerful effects. It is also possible that actual drug use involves many other factors (e.g., situational, contextual) than just environmental stimuli, and interoceptive drug-related stimuli, like cognitive factors, could have a greater impact on reactivity. This appears to be true in this study, as the belief about when cigarettes were next available elicited greater reactivity in almost all of the outcome variables (e.g., positive mood, negative mood, reaction time, withdrawal) than did exposure to environmental stimuli. Therefore, results from
This study highlights the significant impact of cognitive factors as a distinct CS within cue reactivity research.

There was a main effect of the availability manipulation on negative mood. Those told smoking would be unavailable for an extended period of time (e.g., 24 hours) showed significantly increased negative mood compared to those told smoking would be soon (e.g., 20 minutes) or at the end of the study (e.g., 3 hours). No significant differences were found for negative mood between the 20 mins and 3 hrs conditions. This is consistent with Juliano and Brandon (1998), as well as Ross and Juliano (2015), who also found that smokers in the 24 hr conditions had significantly greater negative mood relative to the 3 hr and 20 min conditions, with no difference between the latter two conditions. Other studies that have manipulated the probability of smoking have also found increased negative affect as the probability of smoking decreases (Bailey et al., 2010; Carter & Tiffany, 2001).

The negative mood finding makes sense given how difficult it is for daily smokers to think about and work toward long-term abstinence. Further, this sample was comprised of non-treatment-seeking smokers, so that idea of quitting smoking for a day was likely not something they thought about or wanted at the time. In addition, the significant increase in negative mood for these smokers could be a sign of reactivity to study instructions. This is important to note, as their responses to this measure may reflect their reactions to feeling deceived, rather than experiencing negative mood due to their upcoming abstinence, or it could be a combination of both. Future studies should find a way to better parse out these nuances.

Withdrawal and negative mood were very highly correlated across all subjects, regardless of availability condition ($r = .87, p < .01$). It is likely that smokers who experience withdrawal and withdrawal-like symptoms will also experience negative affect. This high correlation reflects this and also suggests that subjects were paying attention to the measures and what the items
were assessing. This is reassuring, given the multiple time points of assessment used in this study. Despite this, uncertainty exists in determining the independence of these constructs, and future research is needed to better parse out these nuances.

There were no significant effects of the manipulations on positive mood. Surprisingly, there were no significant effects found for positive mood in the 20 min conditions (i.e., when smoking is available soon), which has been found in previous research (Bailey et al., 2010; Carter & Tiffany, 2001; Sayette et al., 2003). Ross and Juliano (2015) also found a significant effect of the availability manipulation on positive affect such that smokers in the 24 hr condition had greater decreases in positive affect than those in the 3 hr and 20 min groups. However, Diener and Emmons (1985) reported a dissociated relationship between positive and negative mood, which may account for the significant effect of negative mood but non-significant effect for positive mood. Juliano and Brandon (1998) also failed to find significant main effects for availability on positive affect. Future studies should investigate how the relationship between positive and negative mood changes across different smoking availability manipulations.

There was a main effect of the availability manipulation on withdrawal. Individuals who were told smoking was unavailable for 24 hrs had significantly greater increases in withdrawal than the 20 mins and 3 hrs groups. This pattern of data is consistent with Wikler’s (1973) conditioned withdrawal theory, which states that contextual cues associated with withdrawal can come to elicit conditioned withdrawal responses. Based on this theory, it can be posited that the expectation of extended smoking unavailability (i.e., 24 hrs of smoking abstention) may be associated with withdrawal effects and therefore, subjects who were told that they were unable to smoke for 24 hrs experienced a spike in withdrawal immediately upon hearing the availability manipulation. The pattern of results also displays a trend toward a curvilinear relationship, in that smokers told 20 mins and 24 hrs displayed greater levels of withdrawal than those told 3 hrs.
This relationship did not reach significance, but is important to note given the theoretical propositions discussed above. It is curious, though, why a significant effect for withdrawal emerged, but not for urge. Georgiades and West (2009) studied overnight-abstinent smokers and asked them to rate their withdrawal symptoms and how difficult they had found it not smoking. They found that urges and withdrawal symptoms were unrelated when considering difficulty with not smoking for an extended period of abstinence (e.g., 24 hours), which provides evidence for why the effects for urge and withdrawal differed in the present study. In order to further parse these differences, future studies should develop research designs that incorporate both withdrawal and urge as outcomes when assessing for effects of smoking availability and cue reactivity. When considering smoking cessation efforts, it is important to pay attention to the finding that 24 hrs of expected smoking unavailability yielded greater levels of withdrawal. West, Hajek, and Belcher (1989) noted that reducing withdrawal symptoms is a worthwhile target for smoking cessation programs; therefore, future work should develop treatment protocols that target managing withdrawal during the first 24 hrs of smoking abstinence (e.g., distress tolerance skills).

Contrary to predictions, there was no significant effect of the manipulations on reaction time. Previous studies have found slower reaction times for smokers told that smoking would be available sooner than later, and they have theorized that this is due to the effect of competing cognitive processes (Cepeda-Benito & Tiffany, 1996; Ross & Juliano, 2015; Sayette & Hufford, 1994). However, our reaction time analysis displayed a different trend. While the overall ANOCVA failed to reach significant ($p = .089$) the pattern of data reveals a possible curvilinear relationship between smoking availability and reaction time. Pairwise comparisons revealed that those told smoking would not be available for 20 min and 24 hr displayed slower reaction time than those told 3 hrs. This is consistent with the findings of Ross and Juliano (2015).
difference in the reaction time outcomes could be due to how the stimuli were presented to subjects. While other studies brought smoking-related cues into the study room after informing subjects of their expected smoking unavailability, we attempted to reduce potential reactivity by leaving the cues on the participant’s desk (behind a box) and surreptitiously removing the box (and exposed them to the cues) while they were getting ready to answer questionnaires on the computer (Juliano & Brandon, 1998; Ross & Juliano, 2015). Despite our best efforts, this design might not have effectively reduced reactivity to cues, which could have impacted the way they responded to questionnaires. Anecdotally, several participants emphatically noted the presence of the previously hidden cues (e.g., “I can’t believe my cigarettes were there this whole time!”) and appeared irritated and surprised. Other times, the way participants sat at the desk or situated their chairs impeded swift removal of the box. This methodological difference may have contributed to the differences in findings across studies. Future research should focus on ways to effectively expose smokers to cues without increasing reactivity. In addition, as found in Ross and Juliano (2015), self-reported urge and reaction time change scores were not correlated in the present study; however, they were correlated in Juliano and Brandon (1998). Due to the differences in results among these studies, future research is needed to determine the consistency and meaning of reaction time differences among groups. While the present study used a simple reaction time task to measure reaction time, there are other ways to assess the construct; therefore, future work could employ different assessments of reaction time to figure out better ways to detect cognitive disruption.

Smoking Choice Procedure

A smoking choice task was included at the end of the study for exploratory purposes. Cox Proportional Hazards models were run and found that participants who were just now exposed to smoking stimuli were 1.56 times more likely to smoke than those exposed to smoking stimuli a
while ago. This is somewhat surprising, as we would think that those exposed to smoking stimuli for most of the study would experience heightened craving to smoke once being told that smoking was available and smoke sooner. It is possible that those exposed to smoking stimuli at the beginning of the study may have already began using coping skills to deal with the cravings associated with viewing the stimuli. By this point in the study, they may have developed tools to manage the cravings, or their craving to smoke may have decreased enough, to the point where they could continue to abstain (especially given the additional monetary incentive). Also, if the smoking stimuli have been on the desk for a while, it is possible that participants habituated to them, thus causing less of a reaction and minimizing influence on the smoking choice task. Further, participants delayed smoking for a mean of 18.75, 21.33, and 25.83 minutes in the 20 minutes, 3 hours, and 24 hours conditions, respectively. This is surprising also, as it was predicted that those told smoking would be unavailable for 24 hrs would smoke soonest during the smoking choice task. It is possible that those told earlier in the study that they would have to abstain for 24 hours started using coping skills to manage their cravings, and thus when they were introduced to this task (that also provided a monetary incentive), they may have had more cognitive strength to continue resisting smoking until the end of the smoking choice procedure. They may have viewed their increase in negative mood and withdrawal throughout the study as “worth it” if they were able to make more money by the end of the study (i.e., waited longer to smoke). Additionally, those originally told that they would be able to smoke in 20 mins had to delay their anticipated smoking opportunity; they had to continue with study procedures and then were introduced to this task (i.e., all taking more than 20 minutes). As a result, they may not have wanted to wait to smoke anymore, given that they were already planning for immediate smoking. Greater urge, greater negative mood, greater withdrawal, and lower positive mood were all associated with shorter latency to smoke, suggesting that those in the 20 mins groups
were experiencing strong cravings to smoke, frustrated that they had to wait longer to smoke, and were eager to begin smoking. The findings here are supported in the literature. For example, Bold et al. (2013) employed a similar smoking choice task and found that greater pre-task craving predicted smoking sooner in the task. Killen and Fortmann (1997) also found that craving was a risk factor for early relapse. It would be beneficial for future research to assess the use and efficacy of coping strategies before and during a smoking choice task, as it would help to determine factors that contribute to sooner smoking.

Limitations

There are several limitations of this study. For one, we used deception and relied on study participants believing what they were told about when they could next smoke. Experiment evaluation forms were administered at the end of each study session to try to identify subjects for which the manipulations were ineffective. The form included questions asking subjects to describe the purpose of the study, note if they believed there was “more to the study than meets the eye”, and describe aspects of the study that they disliked. Based on this information, we identified several participants who felt that there was more to the study, but only a few who indicated that they knew the true intent of the study. Future researchers should examine ways to assess reactions to smoking unavailability without the use of deception in the laboratory.

Another limitation of this study is potential reactivity to the availability manipulation and exposure to environmental cues. As mentioned earlier, depending on how convincing the researchers were in delivering the information about their next smoking opportunity, participants may have reacted to the instructions in a way that impact their reporting of urge, mood, reaction time, and withdrawal. Further, the method in which the instructions were given (i.e., by verbally relaying the information) may have impacted how the subjects reacted to the information, and different ways of delivering smoking unavailability (e.g., naturalistic settings) could have yielded
different results. In addition, reactivity could have come up when exposing participants to different stimuli. We tried our best to reduce this by leaving the cues hidden in the study room, rather than bringing the cues in and drawing more attention to them; however, it is possible that reactivity still occurred. At times, it was difficult to conceal and remove the cues, depending on where subjects sat and positioned themselves in the study room. It is possible that subjects were exposed to cues prior to when the researcher removed the box and intentionally exposed them, and if this occurred, subject responses to measures could have been impacted. Future research should identify creative ways to reduce subject reactivity while measuring reactions to different environmental stimuli. This would be another place to implement the use of EMA, to determine if naturalistic settings, where stimuli are already present, limit reactivity and yields results that reflect more valid responses.

Compared to national norms for smokers, the sample in this study is disproportionately Black, unemployed, disabled, and low-income. It is important to consider these differences in the sample when trying to conceptualize some of the effects and differences from other studies. When considering the smoking choice task, it is possible that the disproportionately high number of low-income, unemployed smokers were more motivated to abstain for longer to make additional money, and results in this task might have varied if the sample was higher-income and employed (i.e., might not have abstained as long). While it is imperative to actively recruit underserved and minority smoker populations, it is important to consider that these findings, given the specific sample characteristics, may lack generalizability to the broader national smoking sample.

Also, there was no way of ensuring that participants in the 24 hr conditions planned to abstain for 24 hrs at the time of data collection. We attempted to enhance the believability of the manipulation by scheduling a second visit and telling participants that smoking would be
detected through a carbon monoxide test. At the end of the study, we also administered a debriefing questionnaire, which included the question “How much did you intend to follow the instructions about when you could smoke?” to be rated on a 1 (no intentions) to 7 (very strong intentions) scale. Approximately 84% of subjects responded to this question with a 6 or 7, which suggests that most subjects intended on following the smoking availability instructions. While there is no way to adequately measure response bias here, the answers to this question lends hope to investigators that the 24 hr availability manipulation was believable. Manipulations involving expectations of extended abstinence would have greater internal validity in a controlled environment (e.g., inpatient hospital, rehab center).

Another limitation of the study was that subjects may have been aware of the smoking stimuli prior to the manipulation. A baseline urge effect for stimuli ($p = .075$) was detected. As mentioned earlier, we tried our best to conceal cues before cue exposure by keeping them hidden behind a box. However, it is possible that subjects saw the cues at the onset of the study and were experiencing reactivity. When subjects came into the lab, they handed their packs of cigarettes to research staff, who then surreptitiously placed them with the other smoking cues behind the box. It is conceivable that subjects saw researchers place the packs of cigarettes behind the box, thus making them aware of smoking stimuli beforehand. Also, holding and handing over their packs of cigarettes could have served as a form of cue exposure prior to answering baseline questionnaires.

Finally, the urge, mood, and withdrawal measures were administered four times throughout the study (i.e., over the course of an hour and a half). It is possible that a repeated testing effect occurred. Brief measures were selected to minimize burden of completing multiple measures at multiple time points. Moreover, administration was spread out as much as possible, and researchers reinforced to study participants that they should answer the questionnaires based
on how they are feeling right now at this moment. It is possible, though, that participants answered questionnaires in the same way across all four time points, which could have reduced the statistical power of some of the findings.

Future Research

Our sample was comprised of non-treatment-seeking smokers, which may decrease the generalizability of our results, as motivation to quit could be a potential moderator of effects (Wilson et al., 2012). Future research should explore how quitting motivation influences reactions to smoking-related stimuli and smoking availability, with a particular emphasis on extended periods of smoking unavailability. It would be interesting to measure how engagement in cessation efforts impact reactions to these manipulations. For example, a smoker beginning a quit attempt, 3 days abstinent, and 1 week abstinent may all have different reactions to these manipulations, and identifying patterns in responding could be useful when developing smoking cessation treatment manuals. Ideally, this study could be conducted in a residential substance abuse program, where the environment is controlled and measurement can be assessed daily. The present study did not examine the impact of individual differences, such as impulsivity and persistence, which could be important when considering why smokers engage in smoking behavior. Therefore, future studies should evaluate the potential moderating effects of delay-discounting, impulsivity, and persistence on reactions to smoking availability and cue reactivity manipulations. Identifying time points where impulsivity is high and persistence is low could help educate treatment providers on critical times to teach and employ effective coping strategies that specifically target these skill deficits.

Future work should continue to manipulate three more time points of smoking availability to confirm if there is a linear or non-linear pattern of responding across different indices of smoking motivation. While our study has expanded the body of literature to include a
study examining three time points, it was still difficult to determine the shape of the relationship with three time points that were not evenly spaced. Based on the theoretical propositions discussed earlier, it is possible that a curvilinear relationship exists between smoking availability and outcomes. Analyses assessing curvilinear relationships are better suited for studies that examine many time points (e.g., EMA studies), thus future studies could expand this design to include more momentary reactions to smoking unavailability and exposure to environmental stimuli. As smoking unavailability becomes more common with increasing adoption of smoke-free workplaces, parks, and beaches, it is important to investigate how smokers process and react to extended periods of smoking unavailability. It is possible that urge to smoke decreases when smoking is not expected for some period of time due to classical conditioning processes, but then increases when expecting that smoking will not be available for a longer period of time due to anticipatory frustration, impatience, anxiety, or conditioned withdrawal. The finding that smokers in the 24 hrs conditions showed poorest mood and greatest withdrawal symptoms should be examined in future studies. It is important to know if the expectation that one cannot smoke for an extended period of time causes affective and withdrawal changes among smokers who are trying to quit, as this could have implications for cessation success and may help to identify areas to target for treatment.

Furthermore, it is possible that certain features of the study’s design influenced results. That is, a significant availability effect may have been found if subjects had been told that they would be able to smoke immediately rather than sometime within the next 20 mins. As mentioned above, the urge assessment has been criticized in the literature before; therefore, utilizing an alternative urge measure may enhance findings. The assessment of urge can be varied in future studies. Also, if stronger smoking stimuli were used during the cue exposure (e.g., holding a lit cigarette), it is possible that a significant effect for cues would have been
identified. Therefore, future work should attempt to redesign the experiment to include smoking stimuli that are more robust (see Droungas et al., 1995; Sayette & Hufford, 1994; Tiffany & Drobes, 1990). As mentioned above, subject reactivity could have been a reason for a lack of significant findings. Future research should identify creative ways to reduce subject reactivity while measuring reactions to different environmental stimuli. This would be another place to implement the use of EMA, in order to determine if naturalistic settings, where stimuli are already present, limit reactivity and yield results that reflect more valid responses. Successful studies assessing real-time reactions to smoking unavailability could also help to identify research designs that limit the use of deception in the laboratory, as this has introduced limitations across a number of studies. Lastly, as noted earlier, there were some limitations to the implementation of the smoking choice task (i.e., subjects using their phones or sleeping during the waiting period). Future studies should investigate ways to implement the task without these disruptions, in order to get a clearer picture of the mechanisms underlying motivation to smoke.

**Clinical Implications**

The present study provides additional evidence that altering smoking availability influences motivation to smoke. However, the nature of the relationship seems to vary across different indices of smoking motivation. The impact of environmental stimuli on smoking motivation was not clearly delineated in this study, but it is important to examine further and continue to consider in future work. The findings that negative mood and withdrawal was greater for those in the 24 hour conditions should be explored in future studies as it could have important implications for smoking cessation success. By identifying which indices of smoking motivation are affected by making smoking unavailable, we can provide more specific targets for development and implementation of smoking cessation interventions. For example, our results showed that smokers’ negative mood and level of withdrawal increased when they were told they
would have to abstain for 24 hours. Therefore, treatment protocols could be devised that target developing effective coping skills to be used within the first 24 hours of a quit attempt to prevent affect-related smoking lapse.

Cognitive behavioral treatments for smoking cessation might target cultivating distress tolerance and stimulus control skills at the onset of a quit attempt, but might work toward developing emotion regulation, counter conditioning, and reinforcement management skills as treatment progresses throughout a quit attempt. If negative mood is highest when expecting a longer delay from smoking, researchers might consider interventions that are behavioral (e.g., behavioral activation) and cognitive (e.g., cognitive restructuring) during the initial phases of a quit attempt. If withdrawal symptoms (i.e., anger, anxiety, sadness, difficulty concentrating, restlessness) are highest when expecting a longer period of smoking unavailability, researchers might implement strategies that target those specific symptoms. More specifically, if difficulty concentrating and restlessness are heightened during this time, strategies such as relaxation and distraction might be helpful when cognitive resources are limited. Also, when anxiety, anger, and sadness symptoms are increased, strategies such as deep breathing, positive self-talk, and seeking social support may be helpful to incorporate into a cessation protocol. Further, we found that smokers exposed to neutral (i.e., smoking-unrelated) stimuli were more likely to smoke when cigarettes became available. Therefore, future cessation research might consider exploring skills-based approaches (e.g., mindfulness, cognitive restructuring, emotion regulation training), in addition to smoking cue exposure. For many smokers, it may take 30 or more quit attempts before finding quitting success (Chaiton et al., 2016), so it is important for researchers to help identify targeted treatment interventions that help to increase the efficacy of quit attempts. If treatment protocols are developed that offer smokers variety in skills training and target their
specific needs for a successful quit attempt, it is likely that smoking cessation success will improve significantly.

In summary, this study provides additional support for the idea that smoking availability influences motivation to smoke. However, the nature of the relationship appears to differ across different indices of smoking motivation. In order to identify the impact of cue exposure on motivation to smoke, this study also included exposures to smoking-related and neutral cues. No significant impact of stimuli was noted, which provides useful information when considering development of smoking cessation treatment manuals. The finding that participants in the 24 hr conditions showed the poorest mood and greatest level of withdrawal should be explored in future studies, as it could have key implications for smoking cessation success. Using a smoking choice task, we were able to identify which participants, after being told varied information about smoking unavailability and exposed to different stimuli, were more likely to smoke, given the opportunity. This data helped to identify which indices of smoking motivation were affected and provided specific targets for future cessation intervention.
CONSENT TO PARTICIPATE IN A RESEARCH STUDY

TITLE OF STUDY: Smoking Motivation and Reaction Time
PRINCIPAL INVESTIGATORS: Naomi Stahl, B.A., and Laura M. Juliano, Ph.D.

INTRODUCTION
We would like to invite you to be part of a research study at American University. You are eligible to participate because you report that you smoke at least 5 cigarettes per day, have done so for at least the past year, you are at least 18 years of age, and you read and write in English. This is not a treatment to quit smoking. If you are interested in receiving smoking cessation treatment at this time we can refer you elsewhere. This form gives you information about the study. We will answer any questions you have about the study and this consent form. You will be given a copy of this form to keep for your records.

PURPOSE OF STUDY
The purpose of this research study is to evaluate your attitudes towards smoking, and the effects of smoking on feelings, and behavior (particularly reaction time).

PROCEDURES
If you agree to participate, you will be asked to attend up to 2 laboratory sessions. Before the first session, you will be required to abstain from smoking for 3 hours. During the first session, you will be asked to complete questionnaires about your smoking behavior and attitudes, as well as complete computer tasks that assess your reaction time. You will also be asked to provide a breath sample so that we can measure the amount of carbon monoxide in your body, which is an indicator of how much you smoke. This first session could last up to 3 hours and you may be given the opportunity to smoke a cigarette at the end of the study. You may also be asked to return to the laboratory the day after your first session for a brief session to provide a carbon monoxide breath sample and answer questionnaires on the computer.

RISKS/DISCOMFORT
You may experience some mild discomfort as a result from abstaining from cigarette smoking. Nicotine withdrawal symptoms could include headache, fatigue, difficult concentrating, irritability, and cigarette cravings.

CONFIDENTIALITY
All data collected from you will be kept completely confidential. A numeric code will be used in place of your name on all forms. Your records will be stored in a locked file cabinet in the
Behavioral Pharmacology and Health Promotion Laboratory (Asbury Room 137) and in computer files that are password protected. Video tapes of your smoking will be stored in encrypted computer files and destroyed after the end of the study. All data will be combined for analyses and publication. The researcher retains the right to use and publish non-identifiable data.

**BENEFITS**
Participating in this research will provide no direct benefits to you. It is hoped that the information gained from this study will allow us to learn more about motivation to smoke. This could ultimately benefit the larger population of smokers.

**ALTERNATIVES TO PARTICIPATION**
Your participation in this study is completely voluntary. You have the right to stop the study at any time and be paid for the time you have already put in. Your decision to discontinue participation will not affect your standing in any course nor your entitlement to receive compensation for initiating participation. This is **not** a treatment to quit smoking. If you would like to quit smoking, we can provide you with the names and numbers of agencies that can help you to quit.

**COMPENSATION**
You will be compensated $35 for your participation in the study. You can also earn $10 for travel compensation for coming to our office. If you are an AU student, you may choose to earn 2.0 research credits rather than monetary compensation. You can also earn up to $5.00 for a smoking task at the end of the session.

This study has been approved by the Institutional Review Board, American University. If you have any questions or concerns about this study you can contact the Primary Investigator for this study, Dr. Laura Juliano at juliano@american.edu or 202-885-1715. You may also contact Anthony Ahrens, the Chair of the Institutional Review Board at ahrens@american.edu or 202-885-1714 if you have any concerns about your rights as a research participant.

**By signing below, you certify that you fully understand the nature and purpose of the study, potential benefits, and possible risks associated with participation.**

Printed Name of Participant: ________________________________

Signature of Participant: ________________________________ Date: __________

**INVESTIGATOR'S AFFIDAVIT:** I certify that I have explained to the above individual(s) the nature and purpose of the study, potential benefits, and possible risks associated with participation in this study. I have answered any questions that have been raised.

Printed Name of Individual Obtaining Consent: ________________________________

Signature: ________________________________ Date: __________
APPENDIX B

MEASURES

I. Telephone Form to Screen for Eligibility to Participate

Contact Information

Name: ________________________________
Email address: ____________________________

Gender: ____ B  Best phone number to reach you at: __________________________
Okay to leave message?  Yes  No

Race/Ethnicity: ________________

Reference Source (Where did you hear about the study?):
  AU Newspaper  Other Newspaper  Craigslist  Classroom  Other AU Lab  Flyer  Other: ___________

Information regarding study and requirements of participation – To be read to volunteer

The purpose of this research study is to evaluate your attitudes towards smoking, and the effects of smoking on feelings, and behavior (particularly reaction time). This study is not intended to be a treatment for smoking.

If you agree to participate, you will be asked to attend up to 2 laboratory appointments and abstain from nicotine, including cigarettes, for 3 hours prior to your first visit. The first appointment will take up to three hours, while the second appointment will be brief. At both appointments, you will be asked to provide a carbon monoxide reading so that we can measure your smoking exposure. In addition, you will be asked to complete questionnaires and computer tasks. If you agree to participate, you will be compensated $35 or 2.0 research credit hours plus $10 for travel compensation to our office. You can also earn up to $5.00 extra based on a laboratory task.

Based on this information, are you interested in determining if you are eligible to participate?
(If no) Thank you for your time. Would you like us to keep your contact information for any future studies that come up?
(If yes) I would like to ask you a few questions.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How old are you? (must be ≥ 18 years old)</td>
<td>Age: ___________</td>
</tr>
<tr>
<td>2. How many days a week do you smoke cigarettes? (must be everyday)</td>
<td>Write in #:</td>
</tr>
</tbody>
</table>
### Eligibility Criteria

Not eligible or Unclear ➔ SAY, “OK, we are going to pass your information to the person in charge of the study, we will give you a call back by the end of the day if you are eligible. If you don’t hear from us then that means that you are not eligible for this particular study but if it’s alright with you we will keep your name and number and we will call you for any future studies you may qualify for.”

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Can you read printed materials in English/use a computer?</td>
<td></td>
</tr>
<tr>
<td>4. Do you smoke marijuana or other nicotine or non-nicotine products?</td>
<td></td>
</tr>
<tr>
<td><em>If yes:</em> Would you be willing to abstain for the duration of the study?</td>
<td></td>
</tr>
<tr>
<td>5. How many cigarettes do you smoke per day on average?</td>
<td></td>
</tr>
<tr>
<td>(must be 5 cigarettes everyday)</td>
<td></td>
</tr>
<tr>
<td># cigs:</td>
<td></td>
</tr>
<tr>
<td>6. How long have you been smoking?</td>
<td></td>
</tr>
<tr>
<td>(must be smoking for a minimum of one year)</td>
<td></td>
</tr>
<tr>
<td>Yrs Smoking:</td>
<td></td>
</tr>
<tr>
<td>7a. What brand of cigarettes do you smoke?</td>
<td></td>
</tr>
<tr>
<td>7b. What strength cigarettes do you smoke?</td>
<td></td>
</tr>
<tr>
<td>7c. Do you smoke menthol or non-menthol cigarettes?</td>
<td></td>
</tr>
<tr>
<td>Brand:</td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Light</td>
<td></td>
</tr>
<tr>
<td>Non-menthol</td>
<td></td>
</tr>
<tr>
<td>Menthol</td>
<td></td>
</tr>
<tr>
<td>8a. Do you have any chronic smoking-related health problems?</td>
<td></td>
</tr>
<tr>
<td>Have you ever had any of the following problems?</td>
<td></td>
</tr>
<tr>
<td>Chronic Bronchitis</td>
<td></td>
</tr>
<tr>
<td>Chronic Obstructive Pulmonary Disease</td>
<td></td>
</tr>
<tr>
<td>Emphysema</td>
<td></td>
</tr>
<tr>
<td>Specify:</td>
<td></td>
</tr>
<tr>
<td>8b. If asthma: Do you use a pump? Have you ever had an attack?</td>
<td></td>
</tr>
<tr>
<td>9. Do you use any of the following:</td>
<td></td>
</tr>
<tr>
<td>Nicotine gum, nicotine patch, nicotine lozenge, nicotine spray, Wellbutrin, or Chantix?</td>
<td></td>
</tr>
<tr>
<td>10. For females: Are you pregnant or nursing a child?</td>
<td></td>
</tr>
<tr>
<td>11. For females: Is there any chance you could become pregnant during the time you would be participating in the study?</td>
<td></td>
</tr>
</tbody>
</table>
Eligible, move on to schedule the appointment:

Date: ________________  Time: ________________

II. Demographics and Smoking History Questionnaire

Instructions: Please answer each question by selecting the appropriate box or by writing in the answer, if indicated.

1. Gender:  Male  Female

2. Age: ________________

3. What is your current marital status?
   - Single
   - Married
   - Separated
   - Divorced
   - Other: ________________

4. What race do you consider yourself to be?
   - American Indian or Alaska Native
   - Asian
   - Black or African-American
   - Native Hawaiian or Other Pacific Islander
   - White
   - Other: ________________

5. Do you consider yourself to be Hispanic or Latino?  No  Yes

6. Are you a student?
   - No
   - Yes, part time
   - Yes, full time

7. What is your employment status?
   - Employed F/T
   - Employed P/T
   - Unemployed
   - Retired
   - Disability

8. How many years of education have you completed? (Choose one)
   - 1 year (Elementary School)
   - 2 years (Elementary School)
3 years (Elementary School)
4 years (Elementary School)
5 years (Elementary School)
6 years (Middle School)
7 years (Middle School)
8 years (Middle School)
9 years (High School)
10 years (High School)
11 years (High School)
13 years (Some College)
14 years (Vocational or Community College Degree)
16 years (Four Year College Degree)
17 years (Some Postgraduate Work)
18 years (Postgraduate degree; Master’s Degree)
20 years (Postgraduate Degree; M.D., Ph.D., DDS, Dr. P.H., etc.)

9. What is your total family income per year, before taxes? (Choose one)
   Less than $10,000 per year or less than about $833 per month
   $10,000 to $19,999 per year or less than about $1250 per month
   $20,000 to $29,000 per year or less than about $2083 per month
   $30,000 to $39,000 per year or less than about $2916 per month
   $40,000 to $49,000 per year or less than about $3750 per month
   $50,000 to $59,000 per year or less than about $4583 per month
   $60,000 to $69,000 per year or less than about $5416 per month
   $70,000 to $79,000 per year or less than about $6250 per month
   $80,000 to $89,000 per year or less than about $7083 per month
   $90,000 to $99,000 per year or less than about $7916 per month
   $100,000 or more per year or more than $8333 per month

10. How many cigarettes do you smoke per day on average? __________

11. How many years have you been smoking daily? __________

12. How soon after you wake up do you smoke your first cigarette?
    Within 5 minutes
    6-30 minutes
    31-60 minutes
    After 60 minutes

13. Do you find it difficult to refrain from smoking in places where it is forbidden (e.g., in church, at the library, in cinema etc.)?  No  Yes

14. Which cigarette would you hate most to give up? (check one)
    The first one in the morning
    The cigarette with/after breakfast
The cigarette with/after lunch
The cigarette with/after dinner
The last cigarette before going to bed
Other: ____________________

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

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

17. What is your desire to quit smoking at this time?
   1 - No desire at all
   2
   3
   4
   5
   6
   7 - Very strong desire

18. What brand of cigarettes do you smoke most of the time? ________________

19. Do you typically smoke menthol or non-menthol cigarettes?
   Non-Menthol
   Menthol

20. What strength cigarettes do you smoke most of the time?
   Ultralight
   Light
   Medium
   Regular

21. What size cigarette do you smoke most of the time?
   Kings
   100s
   Other: __________

22. Do you currently use any other tobacco products (i.e., chewing tobacco, cigars, pipes)?
   Yes    No

23. If you answered yes to the previous question, (Do you currently use any other tobacco products (i.e., chewing tobacco, cigars, pipes)?), what product(s) do you use and how often do you use it?: ____________________ How often? ____________________

24. Are you seriously thinking about quitting smoking?
   Yes, within the next 30 days
Yes, within the next 6 months
No, not thinking about quitting

25. Have you ever made a serious attempt to quit smoking in which you remained abstinent for at least 24 hours?________

26. How many times have you made a serious attempt to quit smoking in which you remained abstinent for at least 24 hours?________________________

27. How long ago (in days) was your last serious attempt to quit smoking?_______________________

28. During your last quit attempt how long (in days) did you remain abstinent (that is, without taking even one puff on a cigarette)?______________________________________________

29. Other than yourself, how many individuals in your immediate household smoke cigarettes?
   0
   1
   2
   3
   4
   5
   6+

30. If you were to quit smoking, how confident are you that if you had one cigarette you could go back to being abstinent?
   1- Not at all confident
   2
   3
   4
   5
   6
   7
   8
   9
   10 – Extremely confident

31. How many days in the past month have you consumed drinks containing alcohol? _______

32. How many drinks containing alcohol do you consume in a typical week? A standard drink is 12 oz beer, 5 oz wine, or 1.5 oz liquor (1 shot). __________

III. Mood Scale (DE-2)

Instructions: Please read each statement and circle the number that best describes how you feel right now.
1. **Angry/Hostile.**
   
   0 1 2 3 4 5 6
   
   Not at all  Extremely Much

2. **Happy.**
   
   0 1 2 3 4 5 6
   
   Not at all  Extremely Much

3. **Worried/Anxious.**
   
   0 1 2 3 4 5 6
   
   Not at all  Extremely Much

4. **Joyful.**
   
   0 1 2 3 4 5 6
   
   Not at all  Extremely Much

5. **Depressed/Blue.**
   
   0 1 2 3 4 5 6
   
   Not at all  Extremely Much

6. **Pleased.**
   
   0 1 2 3 4 5 6
   
   Not at all  Extremely Much

7. **Frustrated.**
   
   0 1 2 3 4 5 6
   
   Not at all  Extremely Much

8. **EnjoymenFrustrated.**
   
   0 1 2 3 4 5 6
   
   Not at all  Extremely Much

9. **Unhappy.**
   
   0 1 2 3 4 5 6
   
   Not at all  Extremely Much

**IV. Urge Questionnaire**
Instructions: Please indicate how much you agree or disagree with each of the following statements.

1. I have a desire for a cigarette right now
   
   0 – Not at all
   10
   20
   30
   40
   50
   60
   70
   80
   90
   100 – Greatest desire I have ever experienced

2. I do want to smoke now.
   
   0 – Not at all
   10
   20
   30
   40
   50
   60
   70
   80
   90
   100 – Greatest wanting I have ever experienced

3. I crave a cigarette right now.
   
   0 – Not at all
   10
   20
   30
   40
   50
   60
   70
   80
   90
   100 – Greatest craving I have ever experienced

V. Withdrawal Scale (Minnesota Nicotine Withdrawal Questionnaire)

Please rate the following items based on how you are feeling right now.
0 = none, 1 = slight, 2 = mild, 3 = moderate, 4 = severe

1. Angry
2. Irritable
3. Frustrated
4. Anxious
5. Nervous
6. Depressed mood, sad
7. Desire or craving to smoke
8. Difficulty concentrating
9. Increased appetite, hungry,
10. Insomnia, sleep problems, awakening at night
11. Restless
12. Impatient

VI. Smoking Consequences Questionnaire

Directions: This questionnaire is designed to assess beliefs people have about the consequences of smoking a cigarette. We are interested in your general expectations about the consequences of your smoking. Below is a list of statements. Each statement contains a possible consequence of smoking. For each of the statements listed below, please rate how LIKELY or UNLIKELY you believe each consequence is for you when you smoke.

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completely</td>
<td>Very</td>
<td>A little</td>
<td>Somewhat</td>
<td>A little</td>
<td>Somewhat</td>
<td>Very</td>
<td>Completely</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
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</tr>
</tbody>
</table>

1. Cigarettes taste good. 0 1 2 3 4 5 6 7 8 9
2. Smoking controls my appetite. 0 1 2 3 4 5 6 7 8 9
3. My throat burns after smoking. 0 1 2 3 4 5 6 7 8 9
4. Cigarettes help me deal with anxiety or worry. 0 1 2 3 4 5 6 7 8 9
5. Nicotine "fits" can be controlled by smoking. 0 1 2 3 4 5 6 7 8 9
6. When I'm angry a cigarette can calm me down. 0 1 2 3 4 5 6 7 8 9
7. When I'm alone, a cigarette can help me pass the time. 0 1 2 3 4 5 6 7 8 9
8. I become more addicted the more I smoke. 0 1 2 3 4 5 6 7 8 9
9. If I'm tense, a cigarette helps me to relax. 0 1 2 3 4 5 6 7 8 9
10. Cigarettes keep me from overeating. 0 1 2 3 4 5 6 7 8 9
11. Smoking a cigarette energizes me. 0 1 2 3 4 5 6 7 8 9
12. Cigarettes help me deal with anger. 0 1 2 3 4 5 6 7 8 9
13. Smoking calms me down when I feel nervous. 0 1 2 3 4 5 6 7 8 9
14. Cigarettes make my lungs hurt. 0 1 2 3 4 5 6 7 8 9
15. I feel like I do a better job when I am smoking. 0 1 2 3 4 5 6 7 8 9
16. A cigarette can give me energy when I'm bored and tired. 0 1 2 3 4 5 6 7 8 9
17. Cigarettes can really make me feel good. 0 1 2 3 4 5 6 7 8 9
18. When I'm feeling happy, smoking helps keep that feeling. 0 1 2 3 4 5 6 7 8 9
19. I will enjoy the flavor of a cigarette. 0 1 2 3 4 5 6 7 8 9
20. If I have nothing to do, a smoke can help kill time. 0 1 2 3 4 5 6 7 8 9
21. I will enjoy feeling a cigarette on my tongue and lips.
22. Smoking will satisfy my nicotine cravings.
23. I feel like part of a group when I'm around other smokers.
24. Smoking makes me seem less attractive.
25. By smoking I risk heart disease and lung cancer.
26. Smoking helps me enjoy people more.
27. Cigarettes help me reduce or handle tension.
28. I feel better physically after having a cigarette.
29. I enjoy parties more when I am smoking.
30. People think less of me if they see me smoking.
31. A cigarette can satisfy my urge to smoke.
32. Just handling a cigarette is pleasurable.
33. If I'm feeling irritable, a smoke will help me relax.
34. Smoking irritates my mouth and throat.
35. When I feel bored and tired, a cigarette can really help.
36. I will become more dependent on nicotine if I continue smoking.
37. Smoking helps me control my weight.
38. When I'm upset with someone, a cigarette helps me cope.
39. The more I smoke, the more I risk my health.
40. Cigarettes keep me from eating more than I should.
41. I enjoy the steps I take to light up.
42. Conversations seem more special if we are all smoking.
43. I look ridiculous while smoking.
44. Smoking keeps my weight down.
45. I like the way a cigarette makes me feel physically.
46. Smoking is hazardous to my health.
47. I enjoy feeling the smoke hit my mouth and back of my throat.
48. When I smoke, the taste is pleasant.
49. I like to watch the smoke from my cigarette.
50. When I am worrying about something, a cigarette is helpful.
51. Smoking temporarily reduces the repeated urges for cigarettes.
52. I enjoy the taste sensations while smoking.
53. I feel more at ease with other people if I have a cigarette.
54. Cigarettes are good for dealing with boredom.
55. Smoking is taking years off my life.
II. Motivation to Quit Form (Contemplation Ladder)

THE CONTEMPLATION LADDER

Instructions: Each rung on this ladder represents where various smokers are in their thinking about quitting. Circle the number that indicates where you are NOW.

10 → Taking action to quit (e.g., cutting down, enrolling in a program).
9 → Starting to think about how to change my smoking patterns.
8
7
6
5 → Think I should quit but not quite ready.
4
3
2 → Think I need to consider quitting someday.
1
0 → No thought of quitting.

VIII. Delayed Discounting (Kirby-5) Questionnaire

Directions: For each of the next 27 choices, please indicate which reward you would prefer by circling your answer: the smaller reward TODAY, or the larger reward in the specified amount of days.

1. Would you prefer $54 today, or $55 in 117 days?
2. Would you prefer $55 today, or $75 in 61 days?
3. Would you prefer $19 today, or $25 in 53 days?
4. Would you prefer $31 today, or $85 in 7 days?
5. Would you prefer $14 today, or $25 in 19 days?
6. Would you prefer $47 today, or $50 in 160 days?
7. Would you prefer $15 today, or $35 in 13 days?
8. Would you prefer $25 today, or $60 in 14 days?
9. Would you prefer $78 today, or $80 in 162 days?
10. Would you prefer $40 today, or $55 in 62 days?
11. Would you prefer $11 today, or $30 in 7 days?
12. Would you prefer $67 today, or $75 in 119 days?
13. Would you prefer $34 today, or $35 in 186 days?
14. Would you prefer $27 today, or $50 in 21 days?
15. Would you prefer $69 today, or $85 in 91 days?
16. Would you prefer $49 today, or $60 in 89 days?
17. Would you prefer $80 today, or $85 in 157 days?
18. Would you prefer $24 today, or $35 in 29 days?
19. Would you prefer $33 today, or $80 in 14 days?
20. Would you prefer $28 today, or $30 in 179 days?
21. Would you prefer $34 today, or $50 in 30 days?
22. Would you prefer $25 today, or $30 in 80 days?
23. Would you prefer $41 today, or $75 in 20 days?
24. Would you prefer $54 today, or $60 in 111 days?
25. Would you prefer $54 today, or $80 in 30 days?
26. Would you prefer $22 today, or $25 in 136 days?
27. Would you prefer $20 today, or $55 in 7 days?
APPENDIX C

RECRUITMENT MEASURES

I. Recruitment Flyer

SMOKERS WANTED FOR PAID PARTICIPATION IN RESEARCH

The Behavioral Pharmacology & Health Promotion Laboratory at American University is recruiting smokers to participate in a research study examining motivations for cigarette smoking.

Participation involves attending up to 2 lab visits. During this time, you will complete questionnaires and tasks on the computer.

You will receive up to $35 (plus $10 travel compensation) or 2.0 research credits. You can also earn up to $5.00 extra based on a laboratory task.

Please call 202-885-1792 or email bphplab@gmail.com and reference Study 033.
II. Text for Newspaper Advertisement and Email to Psychology Students

Daily smokers wanted for paid participation in research studying smoking motivations. Participation requires up to two laboratory visits, and three hours of smoking abstinence before your first visit. Qualified participants will be paid $35.00 (plus $10 travel compensation) and up to an extra $5.00 based on a laboratory task. Please call (202)-885-1792 or email bphplab@gmail.com if interested.

III. Craigslist Advertisement

Smoking Study – DAILY SMOKERS NEEDED FOR PAID PARTICIPATION IN RESEARCH (American University)

Date: __________, _______ EST
Reply to: bphplab@gmail.com.

We are seeking daily smokers for a PAID research study at American University.

Study Details: Daily smokers are wanted for paid participation in research studying smoking motivations. Participation requires up to two laboratory visits, and three hours of smoking abstinence before your first visit.

Compensation: Smokers will earn $35 for their participation for brief assessments (plus $10 travel compensation) and up to $5.00 extra based on a laboratory task.

Interested? Please call 202-885-1792 and complete a brief phone screen to see if you are eligible. If you prefer, we can call you if you email us your telephone number by replying to this post. Please mention Study 033 when you call or email.

- Location: American University
- it's NOT ok to contact this poster with services or other commercial interests

IV. Today@AU Advertisement

<table>
<thead>
<tr>
<th>Title</th>
<th>Smoking Motivation and Reaction Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body</td>
<td>Daily smokers are wanted for paid participation in research studying smoking motivations. Participation requires 1-2 laboratory visits, and three hours of smoking abstinence before your first visit. Qualified participants will be paid $35.00 or 2 research credits. Participants can also earn up to $5.00 extra based on a laboratory task.</td>
</tr>
<tr>
<td>Notes</td>
<td>IRB approval number:</td>
</tr>
<tr>
<td>Requested Start Date</td>
<td>--</td>
</tr>
<tr>
<td>Requested End Date</td>
<td>• Display max # of days</td>
</tr>
<tr>
<td>Target Audiences</td>
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</tr>
<tr>
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<td>Academics- Research and Grants</td>
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</tr>
<tr>
<td>Department</td>
<td>College of Arts and Sciences</td>
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<tr>
<td>SubDepartment</td>
<td>Department of Psychology</td>
</tr>
<tr>
<td>Contact</td>
<td>Behavioral Pharmacology and Health Promotion Laboratory</td>
</tr>
<tr>
<td>Email</td>
<td><a href="mailto:bphplab@gmail.com">bphplab@gmail.com</a></td>
</tr>
<tr>
<td>Phone</td>
<td>202-885-1792</td>
</tr>
</tbody>
</table>
APPENDIX D

EXPERIMENT EVALUATION

EXPERIMENT EVALUATION FORM

Instructions: Answer each question by placing an X in the appropriate space or by writing in the answer, if indicated.

1. How would you rate your experience as a research participant in this project?
   - very poor
   - poor
   - neutral
   - good
   - excellent

2. Would you like to be a research participant again in the future if the opportunity arises?
   - definitely not
   - most likely not
   - maybe
   - most likely yes
   - definitely yes

3. Would you recommend this study to friends or family?
   - definitely not
   - most likely not
   - maybe
   - most likely yes
   - definitely yes

4. How interesting was this study for you?
   - very uninteresting
   - somewhat uninteresting
   - neutral
   - somewhat interesting
   - very interesting

5. Did you enjoy participating in this study?
   - no, I disliked it a lot
   - no, I disliked it a little
   - neutral
   - yes, I liked it a little
   - yes, I liked it a lot

6. Did you learn anything from participating in this study?
   - no
   - yes (please describe in the space below)

7. If you had to describe to someone the purpose of this study, what would you tell him or her?

8. Do you think there is more to this study than meets the eye?
   - no
   - yes (please describe in the space below)

9. Is there anything about the study that you disliked?
   - no
   - yes (please describe in the space below)

10. How useful did you find the intervention?
    - not very useful
    - useful
    - very useful

11. In what way/s was the intervention useful?
APPENDIX E
DEBRIEFING MATERIALS

I. Manipulation Check Measure (Debriefing Questionnaire)

Subject # _______________ Date: ____________

1. How difficult would it have been for you to follow the instructions you were given about when you could smoke?

   Not difficult at all 1 2 3 4 5 6 7 Extremely difficult

2. How much did you intend to follow the instructions you were given about when you could smoke?

   No intentions at all to follow the instructions about smoking 1 2 3 4 5 6 7 Very strong intentions to follow the instructions about smoking

3. How confident were you that you could remain abstinent from smoking until you were permitted to do so?

   Not confident at all 1 2 3 4 5 6 7 Extremely confident

4. How confident were you that you could remain abstinent from smoking for 24 hours?

   Not confident at all 1 2 3 4 5 6 7 Extremely confident

5. Is there anything else you would like to share with us about your reactions to the information you were given about when you could smoke?

II. Debriefing Script

Subject # _____________ Date ______________

In this study you were told that this session could last for up to three hours. You were
also told that you would need to return for a second session, which is no longer required. You were given this information so that we can better understand the effect that these beliefs have on a person's motivation to smoke. It is important for researchers to understand all of the factors that influence a person's desire to smoke, and what people believe about when they can smoke is one of those factors.

It is very important that you not discuss this experiment with anyone who might become a participant in the future. This could contaminate their data and yours. In order to use everyone’s data, and be able to come to accurate conclusions, we request that you not discuss the experiment until after they have participated or you are sure they will not. This study should be published in about a year, but if you are interested in looking at the publication, we can send you a copy if you provide us with your email address.

Is this something you would be interested in receiving? If so, record email address below:

__________________________________________________________________________

Do you think you would be able to refrain from speaking to future participants about the specific details of this study?

(Circle one) YES or NO

The experimenter is available to answer any questions you have about the experiment.

Thank you for participating!
REFERENCES


