SOCIAL PROBLEM-SOLVING, NEGATIVE AFFECT, AND SMOKING URGE REACTIVITY DURING BASELINE CUE EXPOSURE

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ABSTRACT

Social Problem-Solving, Negative Affect, and Smoking Urge Reactivity During Baseline Cue Exposure

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Introduction: Despite advances in smoking cessation interventions, the majority of smokers who seek treatment will relapse. To better understand nicotine dependence, and relapse risk factors this study tested for potential relationships between social problem-solving, negative affect, and smoking urges during a baseline smoking cue exposure trial. Methods: aA part of a larger cessation study. 51 male and 50 female physically inactive, sedentary smokers with the intention to quit smoking, and bioverified smoking abstinence (CO < 11ppm) completed demographic questionnaires, the Social Problem-Solving Inventory-Revised: Short-Form, and questionnaires related to smoking history and demographic characteristics. In addition, participants completed a baseline 5-minute relaxation session followed by a 5-minute imaginal and in vivo smoking cue exposure trial. Participants completed pre and post cue exposure measures of urge and affect. Analysis: *t*-tests were used to validate the effect of cue exposure procedures on urge and negative affect. Multivariate linear regression models assessed the strength of possible relationships between social problem-solving, gender, negative affect, and urge to smoke. Results:

Smoking urge and negative affect significantly increased from pre to post exposure. Women and men did not differ on any measure of social problem-solving, affect, or smoking urge. In regression models, the social problem-solving composite score was not statistically associated with post-cue exposure urge strength (as measured by the Questionnaire for Smoking Urges-Brief) when controlling for cigarettes per day or level of nicotine dependence. Greater pre-test negative problem orientation was significantly correlated with pre-post increases in negative affect (a predictor of relapse). In models with a gender and negative problem orientation interaction, negative problem orientation became a stronger predictor of negative affect, although the interaction term was non-significant. Impulsive-careless problem-solving styles and negative affect were also found to be significantly associated with post-exposure urge strength. Conclusions: A 5-minute smoking cue exposure trial produced a reliable increase in smoking urge and negative affect among treatment-seeking smokers who were abstinent for at least three hours. Future research of social problem-solving, stress and coping and negative affect within cue reactivity paradigms may provide insights for integrating cue exposure treatments and counseling-based smoking cessation interventions.

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INTRODUCTION

Public Health Problem

Tobacco smoke contains over 4,000 chemicals and gases, 43 of which are known to be carcinogenic and 400 are known to be toxic, including nicotine, carbon monoxide, ammonia, formaldehyde, butane, benzene, tar, lead, and arsenic (U.S. Surgeon General, 2014). Tobacco use increases the risk for many diseases including cancers, cardiovascular and respiratory diseases, infections, ulcers, and reproductive disorders (U.S. Surgeon General, 2014). Smoking is also dangerous for non-smokers, especially mothers and children. Second-hand smoke exposure increases risk of premature birth, low birth weight, miscarriage, and infant mortality, as well as ear and respiratory infections, asthma, obesity, and cancers (DiFranza, Aligne, & Weitzman, 2004; Kum-Nji, Meloy, & Herrod, 2006).

Tobacco Use Burden and Prevalence

Smoking in the United States has fallen from 43% of the population in 1965 to 18% in 2012. Currently, around 20% of men, 15% of women in the United States smoke daily (U.S. Surgeon General, 2014). Though some progress has been made in reducing smoking, low-income and medically-underserved communities exhibit higher rates of smoking, and higher rates of death and disease from smoking (Howlader et al., 2014). About 28% of people living below the poverty line are smokers, in comparison to 17% above the poverty line (Agaku, King, & Dube, 2014). Ethnic and racial disparities in

disease and death attributable to tobacco have also been observed. In comparison to Caucasians, African Americans, despite having overall lower smoking rates, are more likely to develop and die from lung cancer (Howlader et al., 2014). These effects may be due to a combination of genetics, environmental exposures, lack of access to health screenings, fewer cessation attempts, and less success quitting (Trinidad, Pérez-Stable, White, Emery, & Messer, 2011).

Globally, tobacco causes an estimated six million deaths and one trillion dollars of economic damages every year (World Health Organization, 2012). Up to one billion people could die from tobacco-related diseases if prevalence and death rates remain stable over the rest of the 21st century (World Health Organization, 2013). Even though global rates of smoking have been falling since the 1980s, the absolute number of smokers is still increasing, especially in low-income and developing countries (Ng et al., 2014). Smoking is more prevalent and rising faster in low-income parts of the world where cessation services are less available, and tobacco marketing is unchecked and more aggressive (Abdullah & Husten, 2004). Reducing tobacco use, and increasing the availability and effectiveness of cessation services remain public health priorities (U.S. Surgeon General, 2014; World Health Organization, 2013).

Smoking Cessation and Relapse

Smoking habits are notorious for being one of the most difficult behaviors to change. Around 70% of smokers report a desire to quit, and more than 50% have tried to quit in the past year (Morbidity and Mortality Weekly Report, 2011). However, many

quit attempts end in relapse. Only 3-5% of unassisted "self-quitters" maintain abstinence for six months or more (Hughes, Keely, & Naud, 2004). Of smokers in cessation programs (receiving counseling and medication), around 60% stay quit for one week, but only 15-40% quit smoking for 12 months or more (Baker et al., 2002; Cahill, Stead, & Lancaster, 2008; Civljak & Sheikh, 2010; Ebbert et al., 2015; Lai, Cahill, Qin, & Tang, 2010; Stead & Lancaster, 2012; Stead, Perera, & Lancaster, 2006). Many smokers make multiple quit attempts: around 60% of ex-smokers needed two or more attempts before quitting successfully, and 10% of smokers report making six or more serious quit attempts in their lifetime (Baker et al., 2002). Awareness of the detrimental effects of smoking, and high rates of relapse have spurred increasing numbers of smokers to seek treatment (Zhu, Lee, Zhuang, Gamst, & Wolfson, 2012).

However, relapse has been defined in different ways. Relapse is sometimes defined as *any* use of the substance after the start of a quit attempt (Hughes et al., 2004). For example, if someone quits, and after 10 days they smoke one cigarette, they are considered to have relapsed (Hughes et al., 2004). More commonly though, the term "lapse" is used to describe "slips" or temporary relapses, and "relapse" is used to describe the *process* of returning to frequent use (Brandon, Vidrine, & Litvin, 2007; Brownell, Marlatt, Lichtenstein, & Wilson, 1986).

Smoking Urges and Withdrawal

The terms "urge" and "craving" are often used interchangeably. Both refer to psychological and physical sensations of drug wanting and the desire to seek out and use

the drug. In this study, "urge" will refer to the self-reported desire to smoke. Urges for drug use, which can range from weak to strong, are typically regarded as a central component of addiction and relapse (Baker, Breslau, Covey, & Shiffman, 2012; Wray, Gass, & Tiffany, 2013). While it is possible that relapses occur in the absence of urges (e.g. smoking to cope with stress), a systematic review indicates that stronger urges are more likely to cause relapses than weaker urges (Wray et al., 2013).

The fact that not every urge results in drug use, or relapse, suggests there is room for personal control over urges to smoke. Perhaps the way people perceive and respond to urges, nicotine withdrawal, temporary lapses, and other high-relapse-risk situations (e.g. high stress) determine whether an urge leads to smoking relapse. Even though each relapse situation is unique, it appears that most relapses share a number of characteristics including (a) urges to smoke, (b) physical withdrawal symptoms (e.g. mood, appetite or sleep disturbance), (c) high stress, and (d) exposure to smoking cues (stimuli and contexts that have been previously associated with smoking and the neurochemical effects of nicotine) (O'Connell & Martin, 1987; Shiffman, 1982; Shiffman, 2005).

Especially in heavy smokers, urges to smoke occur frequently. Typically within three hours of the last dose of nicotine, urges to smoke will increase in frequency and strength, and physical withdrawal begins (Brown et al., 2013). Nicotine withdrawal often involves strong urges to smoke, as well as feelings of stress, irritability, anger, anxiety, depression, frustration and a range of physical disturbances such as jitteriness, tension and changes in sleep and appetite (Edwards & Kendler, 2011; Hughes & Hatsukami, 1986; Ward, Swan, & Jack, 2001).

Nicotine withdrawal lasts about 7-14 days depending on the severity of nicotine dependence (Hughes & Hatsukami, 1986). Urges can continue for longer periods of time, but usually decrease in frequency and severity the longer an ex-smokers remains abstinent (Ussher, Beard, Abikoye, Hajek, & West, 2013). However, one-third of smokers experience urges after being quit for an entire year (Ussher et al., 2013). Because urges and withdrawal are believed to play a prominent role in the maintenance of smoking behaviors and risk for relapse, a great deal of research has focused on (a) the modifiable cognitive-affective processes behind success and failure in resisting urges to smoke (e.g. coping, problem-solving); and (b) how cognitive-affective factors determine the strength of smoking urges. More research is need to understand variability in individual stress and coping characteristics that could ultimately guide more tailored skills training for smokers trying to quit.

How people manage stress is relatively stable, but counseling and problem-solving training can help people engage in more effective resolutions of or adjustments to stress (Nezu, Nezu, & D'Zurilla, 2013). If problem-solving and coping styles are differentially related to the strength of smoking urges, or to mood states related to relapse (e.g. stress, negative affect), improving these functions could reduce relapse risk. To examine the extent to which problem-solving tendencies determine urge strength, this study assessed the strength of smokers' urges during a laboratory-based exposure to familiar smoking cues (e.g. a lit cigarette of the smoker's preferred brand). Understanding how problem-solving, affect, and urges relate in the presence of smoking cues could help clinical researchers (and smokers) intervene on the most important relapse risk factors.

CHAPTER 2

THEORIES OF DRUG DEPENDENCE AND RELAPSE

Biological Theories of Urges and Relapse

While the physiologic and biologic effects of nicotine are not directly measured in this study, smoking cessation interventions should be informed by the underlying biology of addictive behaviors. The central nervous system is naturally equipped with nicotinic receptors (Tuesta, Fowler, & Kenny, 2011). Nicotine is addictive, in part, because it causes changes in dopamine (a key neurotransmitter), especially in the limbic system, the brain's natural reward center (Bush, Luu, & Posner, 2000; Dani & De Biasi, 2001; Di Chiara, 2000). Once stimulated by nicotine and dopamine, the amygdala, and nucleus accumbens in the limbic system are activated (brain structures largely responsible for memory and learning) (Everitt & Robbins, 2005; Lujic, Reuter, & Netter, 2005). Nicotine-induced changes in dopamine activity also effect the functioning of the orbitofrontal cortex, visual cortex and prefrontal cortex (areas of the brain responsible for controlling attention, priority-making, expectations, judgment, value attribution, goal setting and decision-making) (Bush et al., 2000; Jentsch & Taylor, 1999; Paolini & De Biasi, 2011; Zhang et al., 2011).

Nicotine also alters gamma-Aminobutyric acid levels and functioning of the adrenocorticotropic, cholinergic and hypothalamic–pituitary–adrenal (HPA) axis systems (Bruijnzeel, 2012; Di Chiara, 2000; Doyon et al., 2013; Ho et al., 2014; Paterson, Froestl, & Markou, 2005). These biochemical systems are responsible for a range of internal physiologic states (e.g. heart rate, blood pressure) and psychological states (e.g. stress,

negative affect). Comparative neurological studies suggest that the after-effects of nicotine include reduced dopamine activity and stress-like reactions (in terms of HPA-activity) for hours (Doyon et al., 2013).

These systems, while being effected by nicotine, are constantly influencing learning, memory and how people attribute meaning to their experiences, and prioritize future behaviors. Through repeated uses of nicotine, the central nervous system changes in structure and activity in ways that increase the likelihood of smoking. This phenomenon is sometimes referred to as "neuroadaptation" or "incentive-sensitization" (Dagher, Tannenbaum, Hayashi, Pruessner, & McBride, 2009; Paolini & De Biasi, 2011; Robinson & Berridge, 2003; Robinson & Kent, 1993). Once sensitized and dependent on nicotine, people become more likely to perceive and seek out nicotine-related stimuli. In between nicotine dosing, a dependent user will experience acute urges and nicotine withdrawal, and drug seeking becomes a priority. Re-administration of nicotine quickly alleviates withdrawal, urges, and other unpleasant states (e.g. stress) via the process of negative reinforcement. Over time, through the peaks and valleys of nicotine levels in the body, smokers develop the habit of smoking, in part, to reduce or avoid unpleasant feelings of acute withdrawal.

Conditioning Theories of Urge and Relapse

Stimulus-response and conditioning theories suggest that smoking is maintained by exposure to smoking "cues". Cues trigger physiological withdrawal-like states, psychological urges, and drug-seeking behaviors, especially during periods of drug

deprivation (Lazev, Herzog, & Brandon, 1999; Wikler, 1973). Cues are conditioned stimuli (or sets of stimuli) that trigger smoking behaviors due to their previous and ongoing association in time and place with nicotine consumption and rewards (positive reinforcement) and nicotine-related alleviation of negative experiences (negative reinforcement). The associations can form between stimuli (classical conditioning) (Pavlov, 1927) and between behavior and outcomes (operant conditioning) (Skinner, 1953). Smoking cues were not always capable of eliciting urges or smoking behavior. Prior to being a smoker, the sight and smell of cigarettes are considered novel, unconditioned stimuli, and would not incite smoking urge. The person (or animal) exhibits conditioned responses (e.g. urges, drug seeking, drug-taking) only after unconditioned stimuli become conditioned stimuli through repeated pairings between the stimuli and the reinforcing effects of smoking.

However, nicotine is metabolized by the body fairly quickly, so heavily dependent smokers must frequently smoke to prevent withdrawal (Yildiz, 2004). Because nicotine dependence requires frequent dosing, many aspects of life (e.g. mood, daily activities, social experiences, environmental contexts) become cues to smoke. It has been widely hypothesized that the strength and ubiquity of smoking cues is a major source of nicotine dependence and relapse (Conklin & Tiffany, 2002; Niaura et al., 1988).

Smoking Cues

Exteroceptive drug use cues include seeing, smelling, hearing or touching objects related to drug use, and being in environments or contexts previously associated with

drug use (Bouton & King, 1983; Bouton, 2004; Chae et al., 2008; Collins & Brandon, 2002; Wing & Shoaib, 2008). Use of other substances and engagement in other habitual behaviors such as drinking alcohol, coffee, and eating meals are also common smoking cues (Colamussi, Bovbjerg, & Erblich, 2007).

In addition to exteroceptive cues can also be interoceptive. Cues that are interoceptive include desire to smoke, stress, feelings of anxiety, hopelessness, depression, guilt, irritability, anger, frustration, loneliness and weight concerns (Kushnir et al., 2010; McEwen, West, & McRobbie, 2008; Morissette, Brown, Kamholz, & Gulliver, 2006; Morissette, Tull, Gulliver, Kamholz, & Zimering, 2007; Nair, Collins, & Napolitano, 2013; Saladin & Gray, 2012; Sinha, Garcia, Paliwal, Kreek, & Rounsaville, 2006). Physical discomfort such as tension or restlessness and physical changes in autonomic activity (e.g. blood pressure, heart rate) may also internally trigger smoking urges (Hughes & Hatsukami, 1986; Ussher et al., 2013). Changes in nicotine levels, and autonomic activity have been hypothesized to increase drug-seeking activity, and drug consumption, even without conscious awareness of the urge to smoke (Leventhal et al., 2008; Russell, Peto, & Patel, 1974; Tiffany, 1990). This would explain why some smokers report not realizing they had even lit a cigarette.

Contexts and environments can also act as conditioned drug-use cues (Bouton, 2002; Collins & Brandon, 2002; Crombag & Shaham, 2002; Powell, 1995) eliciting withdrawal symptoms and drug-seeking behaviors (Bouton & King, 1983; Collins & Brandon, 2002; Crombag & Shaham, 2002; Wikler, 1948). For example, rats that have been experimentally conditioned to fear a noise in one environment will not respond as

strongly to the noise in a different environment. A return to the conditioned environment restores or renews the previous learning. Smokers, for example, who have smoked more often at a bar or club are more likely to do so again in the future the next time they in that context. This is true because the situation contains many sensory cues (e.g. sight and smell of cigarettes, alcohol), internal cues (e.g. trying to relax after work), social cues, and physical cues (e.g. autonomic activity) that culminate in a powerful, complex conditioned stimuli that can be described as a high risk for relapse situation (G. A. Marlatt & Gordon, 1985).

Positive Reinforcement of Tobacco use

Smoking is positively reinforced through the aforementioned nicotine-induced dopaminergic activations of the limbic system. These activations result in the experience of pleasure, influencing future motivations (approach behavior). Approach and appetitive models suggest that nicotine can shape behavior in the same way food, water, and sex can (Depue & Collins, 1999; Powell, Dawkins, & Davis, 2002). In these theories, people smoke (and relapse) because, in part, they are seeking positive reinforcement from smoking. Experimental research supports appetitive theories of nicotine dependence. For example, humans (and animals) are more likely to self-administer a water and nicotine mix in comparison to water alone, even without knowledge of the contents (Clark, 1969 as cited in Cox, Goldstein, & Nelson, 1984; Hanson, 1979 as cited in Cox, et al, 1984; Donny, Caggiula, Knopf, & Brown, 1995; Goldberg & Henningfield, 1988; Henningfield & Goldberg, 1983).

In addition to positive reinforcement at the biological level, nicotine can be positively reinforcing through perceived effects such as improved alertness and concentration (Stolerman, 1989). These performance-enhancing effects may also motivate future dosing. Social smoking for acceptance, identity, and shared experiences also represent important positive reinforcing aspects of smoking (McEwen et al., 2008; Russell et al., 1974). While daily smoking can be driven by positive reinforcement, smoking, especially in relapse situations, is often influenced by negative reinforcement (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004; Robinson, Lam, & Carter, 2012).

Negative Reinforcement of Tobacco Use

Negative reinforcement occurs when unpleasant and aversive effects of stimuli (e.g. nicotine withdrawal) are alleviated as a function of behavior (Skinner, 1938). According to negative reinforcement associative learning models, relapse risk is often highest when people are experiencing situations in which they have previously smoked not for pleasure, but for the purpose of reducing urges, and withdrawal symptoms (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004). Biologically, nicotine-deprivation in the brain resembles stress, anxiety, and fear (Bruijnzeel, 2012; Doyon et al., 2013; Rose, 2010). Smoking behavior and nicotine ingestion are negatively reinforced because smoking can reduce withdrawal and the associated unpleasant feelings within seconds. This facet of smoking behavior has been hypothesized to distinguish between “chippers” and heavily dependent and relapsing smokers. For example, chippers are less likely to smoke to relieve negative affect and withdrawal (Baker et al., 2004), hence are less likely to

experience negative reinforcement from smoking.

Many studies have confirmed the traditional wisdom that relapses are more likely during times of high stress and negative affect (Berlin & Covey, 2006; Brandon, Tiffany, Obremski, & Baker, 1990; Collins et al., 2004; McEwen et al., 2008; McKay, 1999; O'Connell & Martin, 1987; O'Connell & Shiffman, 1988; Pratt & Brody, 2010; Shiffman & Waters, 2004). A seminal study of telephone quit-line users found that most callers who relapsed (71%) had been experiencing stress and negative affect at the time of relapse (Shiffman, 1982, 1984). Another self-report study found that smoking urges were indeed present during relapses, and that urges joined with negative affect were more likely to result in relapse than urges without negative affect (O'Connell & Martin, 1987).

Negative affect and stress may increase relapse risk through a number of pathways. Biologically, stress and nicotine withdrawal resemble one another, and may exacerbate each other (Bruijnzeel, 2012; Yildiz, 2004). In comparison to smokers with lower stress and negative affect, smokers who exhibited higher stress and negative affect when presented with smoking cues exhibited greater increases fMRI-measured brain activity in regions that produce visual perception, reward, and motivation (Dagher et al., 2009). Experimental research has also demonstrated an amplified attentional bias toward nicotine-related stimuli during times of stress and withdrawal (Cinciripini et al., 2006; McCarthy, Gloria, & Curtin, 2009). These findings align with the proposition that much of the smoking among heavily dependent smokers is motivated by negative reinforcement, restoration of chemical balance and reduction of negative affect and stress. In other words, when experiencing more stress, smokers' brains exhibited stronger

patterns suggesting they were more focused on smoking-related cues. Stress, it appears, can enhance the negative reinforcement value of smoking, and make smoking cues more important in terms of information processing. These effects emerge because 1) stress contributes to the increased sensitivity to smoking cues during nicotine withdrawal and 2) stress and negative affect have themselves become conditioned cues to smoke.

Moreover, increases in relapse risk during times of stress and negative affect have been found to be more apparent for smokers with a history of smoking to cope with stress. In comparison to abstainers, smokers who relapse are more likely to report pre-quit smoking was motivated by stress and negative affect reduction (Bliss, Garvey, Heinold, & Hitchcock, 1989; Chaiton, Cohen, O'Loughlin, & Rehm, 2010; Hall, Muñoz, Reus, & Sees, 1993; Ziedonis et al., 2008). Likewise, people who reported habits of smoking to cope with stressful experiences were more likely to relapse than those who smoked more for pleasure (McEwen et al., 2008). Henceforth, affective processing models of smoking and relapse, indicate that future ex-smokers should focus on learning to reduce and manage the stress in their lives and change their affective and behavioral responses to stress or negative affect so that it does not include smoking. For example, successful abstainers learn to engage in thoughts and behaviors that enable them interrupt to the stimulus-response (stress-smoking) associations that have formed over years of smoking.

Integrating Associative Learning and Cognitive Theories of Relapse

Social Cognitive Theory

According to social learning theory and social cognitive theory, human behaviors (e.g. smoking and relapse) are governed by conditioned stimulus-response associations (Pavlov, 1927; Skinner, 1953). However, these phenomena are subject to the influence of current social and environmental influences and past experiences (previous learning history) (Miller & Dollard, 1941). Social learning theory was later renamed social cognitive theory when higher-order human cognitive processes such as beliefs, attitudes, expectancies, self-efficacy, values and problem-solving were recognized as necessary mediators of the stimuli and response association (Bandura, 1989). Conditioning models help explain why the sight of a cigarette triggers urges. Yet, the same sights and smells will produce different strength in urges, and different probabilities of smoking depending on the smoker's present moment social, environmental, and internal states (e.g. in the presence of other smokers, present moment beliefs about ability to stay quit, stress).

Social cognitive theory suggests that behaviors are more likely to be executed if a person has adequate self efficacy, the belief that they can achieve a desired outcome (e.g. resist the urge to smoke) (Bandura, 1977, 1989). People who have low self-efficacy for quitting smoking may believe that, even if they try to abstain, they will have little chance of staying quit. By contrast, if smokers have higher self-efficacy, they may be more likely to maintain abstinence (Gwaltney, Metrik, Kahler, & Shiffman, 2009).

"Outcome expectancies", a key component of social cognitive theory and other expectancy value theories (e.g. theory of planned Behavior, health belief model) (Ajzen,

1991; Glanz, Rimer, & Viswanath, 2008), describe the effect of a person's beliefs about the consequences (e.g. positive and negative reinforcement) of a behavior if the behavior is executed. According to expectancy theories, the actual consequences of smoking influence action less than the perception or anticipation of smoking outcomes, the "expected utility" (Cooper, Russell, & George, 1988; Robinson et al., 2012; Yong, Borland, Cooper, & Cummings, 2010). For example, recent ex-smokers who are experiencing nicotine withdrawal can expect that if they smoke, withdrawal symptoms will subside. However, if their goal is to maintain abstinence, they must learn new outcome expectancies. Experiencing urges, and practicing healthier coping responses will lead to new outcome expectancies around smoking and urges.

Like any theory, the predictive value of social learning and cognitive-behavior theories is dependent upon researchers' ability to translate them into real-world improvements in interventions efficacy. One possible approach is through research that targets the interface between conditioning factors (e.g. smoking cues, conditioned responses) and social-cognitive factors (e.g. expectancies, attitudes, self-efficacy, problem-solving). For example, the parent study to this dissertation, "Step Up to Quit" combined cue exposure trials with counseling around smoking urge management and coping strategies. This integrated approach acknowledges associative learning and facilitates the development of new outcome expectancies around stress and smoking urges. Successful smoking urge management requires the on-going use of a myriad cognitive-behavioral resources such as task persistence, negative affect and stress management, emotion regulation, self-efficacy, and problem-solving (Brandon et al.,

2003; Gwaltney, Metrik, Kahler, & Shiffman, 2009; Steinberg et al., 2012; Szasz, Szentagotai, & Hofmann, 2012). The following section will elaborate on the public health relevance of cue exposure and related counseling-based components, including the underlying mechanisms and how they can be integrated in research and treatment applications to improve cessation rates and reduce relapse risk.

CHAPTER 3

CUE EXPOSURE RESARCH

Cue Reactivity Introduction

Cue reactivity, also termed "conditioned responses", is the collection of physiologic and psychological responses to conditioned stimuli. Smokers consistently report higher urges to smoke and intentions to smoke after being exposure to smoking cues (Juliano & Brandon, 1998; Sayette & Hufford, 1994; Waters et al., 2004). Reactivity can manifest physically, for example withdrawal and drug-anticipatory states (Collins, Nair, & Komaroff, 2011; Myers & Carlezon, 2010; Nair et al., 2013; Pomerleau, Pomerleau, & Marks, 2000; Sayette, Martin, Wertz, Shiffman, & Perrott, 2001; West & Ussher, 2010). For example, exposure to smoking cues (e.g. a picture of cigarette), in comparison to neutral cues (e.g. a picture of a pen), has been found to elicit increases heart rate and blood pressure (Payne, Smith, Sturges, & Holleran, 1996; Payne, Smith, Adams, & Diefenbach, 2006), increased appetitive salivary response (Collins & Brandon, 2002), increased finger temperature (Payne et al., 1996), increased skin conductance (Drummond & Glautier, 1994; Pomerleau et al., 2000), increased pupil size (Chae et al., 2008), and increased brain activity in reward and motivation-producing substrates (Engelmann et al., 2012; Kushnir et al., 2010; Rait et al., 2012; Wilson, Creswell, Sayette, & Fiez, 2013).

Cue Exposure Treatment Introduction

Cue exposure treatment (CET) is a behavioral intervention used to assess and ultimately reduce cue reactivity. They have also been called "response prevention" interventions in the anxiety literature (Foa, 2011). CET promotes reduction or "extinction" of cue reactivity by repeatedly preventing smoking in the presence of cue-elicited conditioned response (e.g. not allowing someone to smoke during withdrawal, even though a cigarette is presented) (Caggiula et al., 2001; Collins & Brandon, 2002; Collins, Nair, & Komaroff, 2011; Liu et al., 2006; Myers & Carlezon, 2010; Wing & Shoaib, 2008). Most CET and cue reactivity studies have used 1-10 minute trials, spread across various intervals, with self-report measures of urges, affect, and sometimes physiologic activity (e.g. heart rate autonomic nervous system) (Carter & Tiffany, 1999; Collins et al., 2011; Drummond & Glautier, 1994; Payne, Schare, Levis, & Colletti, 1991). Exposure trials can involve guided imagery, viewing salient photos, or they can include in-vivo high-salience cues (i.e. lighting a cigarette of the smoker's preferred brand). Eventually, smokers can be trained to use coping skills to manage conditioned responding (e.g. urge, negative affect) when exposed to cues in their daily routine to facilitate extinction of cue reactivity.

Extinction

In conditioning theories "extinction" refers to reductions of cue reactivity that result from repeated instances in which the conditioned stimulus and conditioned responses are no longer paired (Bouton, 2004). However, it should be noted that

extinction learning a CET context (in a clinic), represents new learning. The original stimulus-response associations remain are not unlearned (Bouton, 2004). Extinction-based paradigms are evidenced by animal research models in which experimentally-conditioned motivations (e.g. fear) have been systemically reduced by presenting the conditioned stimulus alone (Bouton & King, 1983; Boyd & Levis, 1983). For example, in a study with rats, a noise is repeatedly paired with a foot shock. Over repeated experiences in which stimulus and response occur close in time, in the same environment, the rat formed an association, at the biological and behavioral level, between the noise and the aversive shock. The rat has changed its behavior; it now reacts to the noise the same way it reacted to the shock (Bouton & King, 1983). Extinction of the noise-shock association was achieved by presenting the noise without the shock enough times that the rat no longer exhibits escape and fear responses when presented with the noise alone (Bouton & King, 1983; Boyd & Levis, 1983; Myers & Carlezon, 2010). Over time, the conditioned response no longer follows the conditioned stimulus (the stimulus becomes a less reliable elicitor of cue reactivity). Human laboratory research has also demonstrated the extinction process (Collins & Brandon, 2002).

However, conditioned responses can return or "spontaneously recover" after extinction, as a function of time. Behavioral evidence currently suggests that, previous associations (memory of previous reinforcement instances) are not gone, or destroyed, but the conditioned response becomes increasingly inhibited with greater levels of extinction (Bouton, 1986; Conklin & Tiffany, 2002; Liu et al., 2006; Rose & Behm, 2004). Also, the original conditioned stimulus-conditioned response association can be

"renewed" by a change in physical context (Collins & Brandon, 2002). Both spontaneous recovery and renewal have important implications in the efficacy of CET applications as they reflect instability of extinction across contexts (Bouton, 1986, 2002, 2004; Collins & Brandon, 2002). However, there are strategies that can improve the generalizability of extinction learning (Collins & Brandon, 2002).

Cue Reactivity and Relapse Risk

Theoretically, the level of cue reactivity and the degree of extinction are determinants of relapse risk. A number of studies found that stronger physical reactions (and less extinction) during cue exposure trials was associated with greater risk for relapse (Marlatt, 1990; Payne et al., 2006; Waters et al., 2004). However, not all studies detect this relationship, and the validity and utility of cue exposure paradigms has been questioned in part because of the instability of extinction learning across contexts (Perkins, 2009). The concerns Perkin's raises are critical. The question Perkins may be asking is "what is the value of producing extinction or measuring reactivity in the laboratory or clinical setting?" However, laboratory-based cue exposure paradigms offer strong internal validity in systematically studying reactivity under different experimental conditions (e.g. varying levels of abstinence, different mood states, with coping skills training). Furthermore, it may be possible to design lab exposures with a greater likelihood of producing extinction that generalizes to real life situations. For example, adding contextual cues (e.g. stress) so as to more accurately create the circumstances around the original conditioning might improve the stability and reliability of extinction.

Cue exposure studies vary considerably by the outcome variable of interest (e.g. cue reactivity, smoking status), and differ in the number and spacing of exposure trials (e.g. massed versus spaced trials), types of cues, mode of presentation (e.g. in-vivo versus imaginal), and the domains of cue reactivity measured (e.g. heart rate, self-report urge). Also, the smokers comprising cue reactivity research samples have widely varied by age, income, geographic region, levels of motivation to quit, current smoking status, level of dependence, cigarettes per day, withdrawal status, and gender and many other variables that make it difficult to synthesize the literature or create "best practices" for CET. To improve the utility of CETs , they have become more integrated with counseling and health education as platform for helping clinicians and treatment-seekers understand drug dependence and create individualized cognitive-behavioral strategies for avoiding smoking, and achieving extinction naturally.

Smoking and Gender: Negative Affect and Cue Reactivity Mechanisms

In addition to extinction facilitation, cue reactivity research may shed light on the role of stress and negative affect in smoking; especially in smokers at higher risk for relapse (e.g. women). For example, cue exposure studies have found that higher negative affect during smoking cue exposure trials is associated with stronger urges and potential delay to extinction (Collins et al., 2011; Payne et al., 1996). Higher levels of negative affect during smoking cue exposures have also predicted a greater likelihood of relapse (Lam & Robinson, 2012). In a study with repeated urge measures across multiple trials, smokers who reported higher negative affect exhibited slower decreases in self-report

urge across trials; less extinction (Collins et al., 2011). These findings suggest that negative affect and stress may exacerbate smokers' experiences of smoking urges and cue reactivity; both acutely and chronically, putting them at higher risk for relapse.

In comparison to men, women have historically had more difficulty quitting smoking (Jarvis, 1994; Robinson et al., 2007). Research evidence suggests that women are more likely than men to smoking to manage negative affect (Collins et al., 2004; Jarvis, 1994; Wetter et al., 1999). This history of smoking leads to increased cue reactivity to smoking cues, especially during stress or negative affect (Carpenter et al., 2014; Collins et al., 2004; Doran, 2013; Ellis, Perl, Davis, & Vichinsky, 2008; Field & Duka, 2004; Kenford et al., 2002; Niaura et al., 1998; Robinson et al., 2007; Wetter & Kenford, 1999). A number of studies have found that smokers in general experience stronger urges when presented with experimental negative affect manipulations, and that this effect was seen most predominantly in women (Field & Duka, 2004; Niaura et al., 1998; Unrod et al., 2013). Similarly, Abrams et al, (1987) found that in comparison to men, women exhibited greater heart rate reactivity in trials with anxiety induction. In contrast, there is evidence that men are more likely than women to maintain smoking due to pharmacologic reward properties of nicotine (Perkins, Donny, & Caggiula, 1999). These hypotheses stem from findings that men, more often than women, have more success quitting smoking with nicotine replacement products (McLean, Asnaani, Litz, & Hofmann, 2011; Perkins, Donny, & Caggiula, 1999; Piccinelli, 2000).

The variability in cue reactivity (and relapse risk) across gender may reflect other differences in the motivations for smoking, such as weight concerns. Body dissatisfaction

(a form of negative affect that could be relieved by smoking in the place of eating) is more common among women, and women smokers are more likely than men to smoke to control their weight (King, Matacin, Marcus, Bock, & Tripolone, 2000). Negative affect from body dissatisfaction and difficulties managing weight could be a driving force in relapse in women but not as much in men. If a smoker is trying to control his or her weight and smokes a cigarette instead of eating breakfast he or she learns that cigarettes are means by which negative affect related to weight or diet can be alleviated. Soon, smoking becomes the response to stress and negative affect in general.

Perceived Stress and Coping: Relapse Risk Factors

Successful abstainers perceive less stress in their lives, and use a greater number of coping strategies when dealing with stress and smoking urges (Abrams et al., 1987; Bliss et al., 1989; O'Connell, Hosein, Schwartz, & Leibowitz, 2007; O'Connell, Fears, Cook, Gerkovich, & Zechmann, 1991; Shiffman, 1984). Abstainers, in comparison to relapsers, also use more effective coping strategies such as planning, generating solutions, comparing outcomes, and post-decision evaluation (Perri & Richards, 1977). Niaura et al, (2002) found that smokers who used any coping strategy during a stress challenge had weaker urges to smoke in comparison to smokers who did report an overt use of a coping strategy. Szasz et al, (2012) found that instructing smokers to use different coping styles (e.g. reappraisal versus suppression) during a persistence (dot-following) task resulted in different levels of negative affect and urge.

Facilitating effective coping skills as part of health and behavior interventions is not new. Clinicians in many fields have long realized that managing stress is key to health and well-being, and avoiding negative health behaviors (e.g. smoking) (Cohen, Janicki-Deverts, & Miller, 2007; Nezu et al., 2013). According to transactional and cognitive appraisal models of stress (Lazarus & Folkman, 1984), stress is experienced (physiologically and psychologically) when people perceive a situation to be threatening, taxing, or endangering wellbeing (Nezu et al., 2013). The magnitude of the stress response is determined by an individual's perceived ability to generate workable strategies, to problem-solve (Nezu et al., 2013).

CHAPTER 4

SOCIAL PROBLEM-SOLVING

In a presentation at the 1968 American Psychological Association:

> *T.J. D'Zurilla and M.R. Goldfried argued that behavioral skills programs should include training in problem-solving skills to facilitate broader and more durable behavior change…problem-solving training can be conceived as a form of self-control training, where individuals learn how to change their own behavior for the better, and thus, function as their own therapist. With these new problem-solving skills, individuals can increase their coping effectiveness across a wide range of problematic situations and, consequently, reduce stress in daily living which, in turn, helps to reduce and prevent stress-related symptoms and disorders* (Nezu et al., 2013).

Social problem-solving (SPS) represents how people attempt to (a) alter the nature of a situation or problem such that it no longer represents a problem, (b) alter their reactions to a problem (emotion-focused coping) or (c) alter both the situation itself, and their response (Nezu et al., 2013). SPS is a "meta-cognitive process" including self-control, beliefs, expectancies, self-efficacy, creativity, planning, evaluation, and decision-making (many of the constructs involved between the stimulus-response relationship, according to social cognitive theory). SPS also describes how people tend to perceive and react to challenges in life, and how much stress they experience in the process.

Quitting smoking is a perfect example of the type of challenge described by SPS models; a difficult, long-term, complex problem with cognitive, affective, social, and physiologic stress-related components. The relevance of SPS to smoking cessation is built on the assumptions that 1) treatment-seeking smokers are looking for ways to alter their own behavior, they want help coping with urges to smoke, 2) some coping strategies

are more effective in producing beneficial and adaptive outcomes when dealing with urges, stress and other negative affect, and 3) people can be taught how to use and practice adaptive problem-solving, thereby building self-efficacy and other cognitive resources. The SPS theoretic framework contains two main factors: problem orientations and problem-solving styles (Nezu et al., 2013).

Problem Orientations

Positive problem orientation refers to an individual's tendency to perceive life's challenges not as stressful, but as opportunities with possible benefits. A positive problem orientation is also characterized by self-efficacy about ability to successfully cope with stress. Previous successes in problem-solving lead to the development of a positive problem orientation. People learn that if they are vigilant, and can temporarily withstand negative emotions to address a problem, or use negative emotions to inform their behaviors, they can identify and successfully cope with stress. These successes may make unpleasant affective and emotional states easier to tolerate in the future. People with a more positive problem orientation are also more likely to use stressful emotions to inform decision-making and find a more effective solution to the problem. These individuals also understand that solving problems can take time, and are thus more able to withstand frustration. Such approaches are more likely to result in effective solutions to problems, and may be essential tools for smoking cessation.

By contrast people with a more negative problem orientation (NPO) may tend to struggle in managing negative affect associated with solving problems (e.g. enduring the

frustration of resisting smoking urges). NPO also describes a tendency to view stressors as threats to wellbeing and to become overwhelmed, and hopeless in the face of challenges. Problem orientation is a relatively stable trait, but can be modified or altered through a first hand experiences, or facilitated through counseling (e.g. problem-solving therapy) (Nezu et al., 2013).

Problem-Solving Styles

"Problem-solving styles", the second main factor in SPS, aims to describe the outward behavior and cognitive strategies that are used in response to stressors and long-term challenges. According to D'Zurilla, Nezu, and Maydeu-Olivares (2002) there are three main problem-solving styles, one adaptive style: rational problem-solving, and two maladaptive styles: avoidant style and impulsive-careless style (Maydeu-Olivares & D'Zurilla, 1996; Nezu et al., 2013).

People who exhibit rational problem-solving styles tend to accurately define problems and stressors, and approach them from a planned, creative and evaluative approach. They are able generate multiple solutions and consider the pros and cons. Rational problem-solving is thought to be more adaptive because it is more likely to result in an effective solution (D'Zurilla & Maydeu-Olivares, 1995; Nezu et al., 2013). For example, being able to generate more than one coping strategy or solution increases the likelihood that a workable solution will be found and executed (Maydeu-Olivares & D'Zurilla, 1996; Nezu et al., 2013).

A person spending more time avoiding rather than solving their problems exhibits an avoidant problem-solving style. Avoiding stressors is thought to be less likely to produce adequate solutions in the long-term, making problems more pervasively stressful (Nezu et al., 2013). Impulsive-careless style, the last problem-solving style, is a tendency (a) to act without considering the consequences of a behavior, (b) to exhibit a lack of inhibition, (c) to have preference for immediate reward, and (d) to exhibit inability to generate multiple possible solutions (Nezu et al., 2013). Impulsive-careless approaches may be maladaptive in that the response was selected and executed without concern for long-term goals.

Impulsivity, although mostly outside of the context of SPS, has been repeatedly identified as a key risk factor for drug use and relapse (Doran, McChargue, & Cohen, 2007; Jentsch & Taylor, 1999). Smokers often exhibit higher levels of impulsivity in comparison to non-smokers (Mitchell, 1999), and it has been found that the same neural substrates responsible for impulsivity may also cause vulnerabilities to substance dependence (Chambers, 2003). Higher impulsivity also predicts an earlier age of smoking onset (Doran, Spring, McChargue, Pergadia, & Richmond, 2004). Neurological evidence suggests that people who are more impulsive are also hypersensitive to reward (Martin & Potts, 2004). Some researchers have suggested that this aspect of impulsivity inhibits people's ability to abstain from smoking. However, it has also been suggested that impulsive smokers are more likely to relapse and to smoke during stress and negative affect (Doran, Spring, & McChargue, 2007; Mitchell, 1999; O'Connell et al., 2007; Wilson et al., 2013). Post-cessation smoking status research indicates that stress and

negative affect most often lead to relapse in people with greater impulsivity (Ansell, Gu, Tuit, & Sinha, 2012). Cue exposure studies indicate that a higher level of impulsivity predicts greater cue reactivity, and greater negative affect during cue exposure trials (Doran, Spring, et al., 2007). Other cognitive-affective-behavioral factors conceptually adjacent to impulsivity, namely task persistence and frustration tolerance, have also been correlated with reactivity and relapse (Brandon et al., 2003; Kalman, Hoskinson, Sambamoorthi, & Garvey, 2010; Steinberg et al., 2012). These constructs describe an individual's ability to withstand negative affective states in order to achieve a desired goal (i.e. smoking cessation). Despite a history of giving into urges to smoke, future ex-smokers must control impulses to smoke and find other ways to respond to stress and negative affect.

Maladaptive Social Problem-Solving and Smoking Relapse

Maladaptive SPS includes negative problem orientation and two problem-solving styles: avoidant and impulsive-careless. As discussed, people who exhibit more negative problem orientation tendencies are more likely to become overwhelmed by stressors, and view them as threats to well being. These perceptions produce higher levels of anxiety (Blankstein, Flett, & Watson, 1992; Bond, Lyle, Tappe, Seehafer, & D'Zurilla, 2002), depression (Heppner & Anderson, 1985; Mccab, Blankenstein, & Mills, 1999; Priester & Clum, 1993), and psychological distress (D'Zurilla & Sheedy, 1991). High levels of maladaptive SPS (i.e. negative problem orientation) have also been linked to greater severity of back pain (Shaw, Feuerstein, Haufler, Berkowitz, & Lopez, 2001), poorer cardiovascular health, and less controlled asthma, among other stress-related chronic

health issues (Garcia, Valdes, & Jodar, 1994; McCormick et al., 2014; Nezu, Nezu, & Jain, 2008). Maladaptive problem-solving and stress are possible risk factors for relapse because they may (a) cause biologically mimic and exacerbate withdrawal, (b) reduce the cognitive resources needed to engage in effective urge management, (c) act as a smoking cue, and (d) amplify reactivity to other smoking cues.

CHAPTER 5

PURPOSE, AIMS, AND HYPOTHESES

Significance of the Study

This study was designed to integrate conditioning and cognitive-affective behavioral models (i.e. SPS) of smoking within a cue reactivity paradigm. The following methods and data analyses provide preliminary assessments of the relationships between social problem-solving and two important relapse risk factors: 1) cue-elicited urge strength, and 2) negative affect. Assessing these variables among treatment-seeking smokers (who are bioverified abstinent for at least three hours) may offer insights into the mechanisms by which people have difficulty quitting smoking. For example, problem-solving styles could be differentially predictive of negative affect and urge strength during smoking cue exposures.

The impetus for this study was also provided by my prior research of SPS and asthma (McCormick et al., 2014). Patients with physician-diagnosed asthma completed questionnaires regarding current life stress, SPS, and asthma control (e.g. severity and frequency of symptoms, medication usage, lung capacity, asthma-related quality of life). In multivariate modeling of asthma outcomes (while controlling for income, age, and gender) impulsive-careless SPS style remained a unique predictor of asthma health and well-being (McCormick et al., 2014). SPS within an asthma-health model was chosen in order to capture the psychobiologic factors such as autonomic arousal and inflammation (Chalmers, 2001), as well as behavioral factors such as “medication adherence” that may impact asthma morbidity. It was reasoned that SPS assessments and counseling programs

aimed to promote adaptive SPS in patients would lead to more sustainable improvements in health. For this study, it is proposed that SPS, through biological and cognitive-behavioral mechanisms, is a determinant of smoking urge strength, negative affect, and relapse risk.

Problem-Solving Therapy (Nezu et al., 2013) has informed interventions such as "behavioral cardiology" which seeks to reduce the patient's risk for negative health outcomes by improving their ability to cope with the emotions and physiologic consequences that follow stressful experiences. Now in the third edition, "Problem-Solving Therapy" lays out a positive psychology, and stress and coping approach to enhancing adaptive problem-solving as a way to avert exacerbations in chronic diseases (Nezu et al., 2013). Similar approaches have been applied to smoking cessation, but not specifically within the context of cue reactivity and extinction paradigms.

Previous research in which interviewers assessed the number and quality of coping skills used by people attempting to reduce their smoking found that greater use of adaptive SPS (e.g. generating multiple coping strategies, task persistence) was correlated with greater reductions in smoking (Perri & Richards, 1977). However, psychometric measures based on the newer, more rigorously tested Nezu and D'Zurilla models of SPS (Nezu et al., 2013) have not been extensively used in smoking cessation research. Furthermore, no studies have examined relationships between SPS and relapse risk factors such as cue reactivity, strength of smoking urges, negative affect, and gender.

Research Aims and Hypotheses

Aim 1: Test the hypothesis that among abstinent, treatment-seeking smokers, social problem-solving and negative problem orientation (NPO) are associated with urge strength following a smoking cue exposure task.

- Hypothesis 1: In comparison to smokers with higher scores on the Social Problem-Solving Inventory-Revised: Short Form (SPSI-R:S), smokers with lower scores will report stronger smoking urges as measured by the Questionnaire for Smoking Urges-Brief (QSU-Brief) following a cue exposure task.
- Hypothesis 2: In comparison to smokers reporting lower negative problem orientation (NPO) SPSI-R:S subscale scores, smokers reporting higher NPO will report stronger smoking urges following a cue exposure task.

Aim 2: Test the hypothesis that negative affect mediates the association between NPO and urge reactivity following cue exposure.

- Hypothesis 1: (repeat of Aim 1 Hypothesis 2)
- Hypothesis 2: In comparison to smokers reporting lower NPO, smokers with higher NPO will also report greater negative affect, as measured by pre-post cue exposure differences in Negative Affect Scale (PANAS) scores.
- Hypothesis 3: In comparison to smokers with less cue-induced negative affect, smokers with greater negative affect will report stronger smoking urges.
- Mediation Hypothesis: Negative affect will mediate the correlation between NPO and smoking urge strength.

Aim 3: Explore moderators of the relationship between NPO and cue reactivity.

- Gender Moderator Hypothesis: Smokers reporting higher NPO will respond to the cue exposure task with stronger urges than those with lower NPO. This difference will be more pronounced among women compared to men.
- Impulsivity Moderator Hypothesis: Smokers reporting higher NPO will respond to the cue exposure task with stronger smoking urges in comparison to individuals with lower NPO, and these differences will be more pronounced among individuals with higher scores on the impulsive-careless SPSI-R:S subscale (ICS).
- Exploratory Hypothesis: Higher impulsivity will predict greater increases in negative affect during the cue exposure tasks.

CHAPTER 6

METHODS AND MEASURES

Parent Study Recruitment and Eligibility

The Temple University Institutional Review Board approved this study as secondary data analyses under protocol number 22403. Data were collected between October 2012 through May 2014 from participants in "Step Up to Quit": an 8-week physical activity, behavioral counseling, and cue exposure study being conducted by Dr. Uma Nair and Dr. Bradley Collins at Temple University's Health Behavior Research Clinic (Collins et al., 2011; Nair et al., 2013). Participants were passively recruited using tear-off flyers posted around Temple University and the local community. Compensation for participation in the parent study included $20 after the baseline assessment and cue exposure session (the session in which data for this study were collected), $30 for the quit-day cue exposure session, and $50 for completing all post-quit day questionnaires.

This dissertation uses data from a select number of hypotheses-related measures taken during an initial phone screening, baseline interview and baseline cue exposure task. This study shared the same eligibility criteria as the parent study (Nair, Collins, Patterson, & Rodriguez, 2015). Participants were tobacco smokers seeking assistance quitting. To meet the goals of the parent study, participants were deemed ineligible if they (a) were less than 18 years old, (b) were more than 59 years old, (c) were pregnant, (d) smoked less than five cigarettes per day, (e) smoked for less than six months, (f) reported co-morbid street drug use (amphetamines, cocaine, crack, PCP, heroin or other street drugs) or alcohol use (more than three drinks per day), (g) had a mental health

diagnosis or prescription, (h) did not report being motivated to quit smoking, (i) were unwilling to abstain from smoking for at least three hours before their appointment, or (j) were regularly physically active (the parent study had aims focused on sedentary smokers).

Procedure

A research assistant assessed eligibility criteria during a telephone interview. Eligible participants then made an appointment for their visit to the research lab. Participants were reminded that they must not smoke for at least three hours before coming in for their visit. Upon arrival, the participants were welcomed, and made comfortable (e.g. able to take off their jackets, offered use of the restroom). The cessation program was then thoroughly described to the participants during the consent process, in which they had multiple opportunities to ask questions about the study and cessation program.

Upon consent, participants completed a carbon monoxide breath analysis using the Bedfont piCO Simple Smokerlyzer. Exhaled carbon monoxide levels above 10 parts per million (ppm) indicated insufficient abstinence from smoking prior to the cue exposure ("Biochemical Verification of Tobacco Use and Cessation," 2002). Participants who exhaled greater than 10 ppm were offered the option of waiting and re-taking the CO test every 15 minutes until their level fell below 11 ppm, or making an appointment for another day. After passing the CO test participants completed a 10-15 minute interview including questions about their contact information, demographics, the number of

cigarettes they smoked each day in the past seven days, level of nicotine dependence with the Fagerstrom Test for Nicotine Dependence (FTND), and social problem-solving with the Social Problem-Solving Inventory-Revised: Short Form (SPSI-R:S). Upon completion of these questionnaires, participants were, again, offered use of the restroom to prevent potential interruptions during the laboratory exposure session.

Participants were then taken to the cue exposure room and introduced to the layout that included a comfortable chair, a one-way mirror to the computer control room, a speaker system, and the turntable with partition that would reveal the smoking cues. The room was equipped with ceiling and floor ventilation to help remove smoke and odor. After being made comfortable in the exposure room, and offered an additional opportunity to use the restroom or ask any questions, participants completed a five-minute relaxation session with soft instrumental piano music. After the music stopped, the research assistant handed the participant a clipboard and pen with the self-report measures of affect, and urge to smoke and asked participants to complete each questionnaire.

Next, the 5-minute smoking cue exposure trial featured a cigarette lighter, ashtray, and a partially full pack of participant-specific brand of cigarettes. During the exposure trial an audiotape instructed participants not to smoke, but to actively look at the cigarettes and paraphernalia, imagine smoking, and eventually handle, light and smell the cigarette. This procedure exposed participants to imaginal, olfactory, visual, tactile and motor cues associated with smoking. Following the exposure, participants completed the same questionnaires about affect and urge to smoke. After the cue exposure task,

participants were taken to another room where they met with the smoking cessation counselor who would explain the purpose of the cue exposure trial and counsel them through the remainder of the parent study and their quit smoking attempt.

Measures

Demographics

Based on similar research(Collins et al., 2011; Nair et al., 2013) and the study aims, the dataset for this study includes the following demographic variables: age, gender, race and ethnicity, income (above or below poverty line), education, employment status, and marital status.

Social Problem-Solving Inventory-Revised: Short Form (SPSI-R:S)

Social problem-solving (SPS) was measured using the Social Problem-Solving Inventory-Revised: Short Form (SPSI-R:S) (D'Zurilla, Nezu, & Maydeu-Olivares, 2002). The 25-item SPSI-R:S contains five questions for each of the five subscales; two problem orientation factors (positive problem orientation and negative problem orientation) and three problem-solving style factors (rational, avoidant, and impulsive-careless). The scales can be analyzed separately or as a composite with raw or standardized scores by age and gender (Nezu et al., 2013). The SPSI-R, which was used to create the short-form, has good test–retest reliability across samples of adolescents, young adults, middle-aged adults, and elderly adults ($r = .79$) and has demonstrated strong structural, concurrent, discriminant, and predictive validity (D'Zurilla et al., 2002). The SPSI-R:S exhibits a

consistent 5-factor structure very similar to the SPSI-R. Confirmatory factor analysis with a large sample size found a comparative fit index of .91 between the original and the short-form (SPSI-R:S) (D'Zurilla et al., 2002). The short form was selected to help minimize participant burden.

Positive and Negative Affect Schedule (PANAS)

Affective states were measured with the PANAS (Watson, Clark, & Tellegen, 1988). The PANAS is a 20-item Likert scale instrument widely used in psychology research that has been previously used in studying tobacco dependence (Thompson, 2007) and cue reactivity paradigms (Kalman et al., 2010). The PANAS was administered following the relaxation trial, and after the smoking cue exposure. Negative affect states assessed by the PANAS include distressed, upset, guilty, scared, hostile, irritable, ashamed, nervous, jittery, and afraid. The PANAS exhibits high validity and reliability (Watson et al., 1988). Validation studies reveal high levels of independence between the positive and negative affective scales. Items within affective valence are highly correlated ($r = .84$ to $r = .90$). The PANAS also exhibits high test-retest reliability ($r = .86$) in student and non-student samples (Crawford & Henry, 2004).

Questionnaire of Smoking Urges-Brief (QSU-Brief)

Cue reactivity research in studying addictions is, in large part, a science of measuring cravings and urges. Sayette, Shiffman, Tiffany and colleagues (2000) suggest that 1) the participants and the researcher must view the questionnaire the same way, 2)

the participant must be able to discern their level of urge, and 3) have willingness to report honestly. Any useful measure of urge or craving must also be able to detect increases in strength of urge when they exist (Watson et al., 1988). The QSU-Brief (Tiffany & Drobes, 1991; West & Ussher, 2010) (see Appendix D) was used to measure strength of smoking urges at pre and post cue exposure. Post-exposure levels were then operationalized as "urge reactivity". The QSU-Brief is a 10-item measure aimed at assessing two factors: "intention to smoke" and "anticipation of relief from negative affect with an urgent desire to smoke" (Cox, Tiffany, & Christen, 2001; West & Ussher, 2010). Together, these factors provide a measure of "global craving" (Cox et al., 2001). Participants provided a value from zero to seven indicating the extent to which they agree with each of the 10 statements on the QSU-Brief. The values on each item are then added to create the final score. The QSU-brief has been found to be a reliable and valid measure of urge to smoke with scores on the brief version exhibiting strong correlations to the full-length QSU ($r = 0.5123$, $p < 0.001$) (Cox et al., 2001).

The 10-item QSU-Brief was used to strike a balance between validity, capturing urge from a multi-dimensional perspective, and minimization of participant burden. Longer versions of smoking urge questionnaires have not been found to be more sensitive to changes in urge (Collins et al., 2011; Cox et al., 2001; Taylor, Ussher, & Faulkner, 2007; Ussher et al., 2013; West & Ussher, 2010). One advantage of self-report measures of cue reactivity and smoking urge is that answering a number of questions about smoking urge does not itself increase urges (Germeroth & Tiffany, 2015). This may not be as true for more invasive physiologic measures that may require setup of unfamiliar

physiologic monitoring equipment, and longer time commitments during data collection.

Additionally, only reported urges can be managed with overt cognitive-behavioral strategies taught in smoking cessation counseling and described by SPS. Thus, self-report measures of urge to smoke may be the most relevant to studies of cognitive-behavioral factors and cue reactivity in comparison to physiologic measures of cue reactivity. It should be stated however, that SPS is also tied to biologic consequences that may impact smokers' physiology by reducing the time between smoking, reducing time to onset of physical withdrawal, and inciting more severe changes in autonomic and hypothalamic-pituitary-adrenal (HPA) axis activity (Steptoe & Ussher, 2006). Through these mechanisms it is possible that SPS and stress can impact urges and smoking behavior at the pre-conscious level. While intriguing, this line of research is outside the purview of this study.

Physiological cue reactivity was not measured, in part, to avoid difficulties discerning signal from noise. Physiologic measures of cue reactivity include gross motor movements that create a large degree of measurement artifact (Chae et al., 2008; Drobes & Tiffany, 1997; Winkler et al., 2011). This complicates signal detection and increases the likelihood that changes in the observed parameter may not be attributable to conditioned reactivity, but rather to some other aspect of the cue exposure and research experience. Further, the changes in physiologic activity, after data cleaning and signal isolation, are often on a very small scale. It is difficult to ascertain the extent to which differences in physiology are clinically meaningful. For these reasons, self-reported strength of urge was deemed the most appropriate measure of cue reactivity in this study.

Fagerstrom Test for Nicotine Dependence (FTND)

Nicotine dependence, which is sometimes controlled for in cue reactivity research, was measured with the Fagerstrom Test for Nicotine Dependence (FTND) (Fagerström, 1978; Shadel, Niaura, Goldstein, & Abrams, 2001). The FTND assesses a person's number of cigarettes smoked per day, amount of time until the first cigarette of the day, strength of cravings, and amount of control smokers maintain over their smoking. The FTND is scored on a scale of one to 10 (see Appendix C).

Scores of one to two indicate low levels of nicotine dependence, scores of three to four indicate low to moderate dependence, five to seven moderate, and eight to 10 indicate high levels of nicotine dependence (Heatherton, Kozlowski, Frecker, & Fagerström, 1991). Level of nicotine dependence is related to cessation outcomes, more heavily dependent smokers are more likely relapse (Payne et al., 1996). However, level of nicotine dependence is not consistently predictive of cue reactivity (Smolka et al., 2006; Vollstädt-Klein et al., 2011). Some studies have failed to detect a relationship between nicotine dependence levels and strength of urge in pre and post-exposure comparisons (Donny, Griffin, Shiffman, & Sayette, 2008; Perkins, 2009). The authors of these studies suggest that level of nicotine dependence may not have had an impact on reactivity because all participants were heavy smokers and scored essentially the same on measures of nicotine dependence. An additional explanation for a potential lack of positive correlation between nicotine dependence and cue reactivity lies in that moderately dependent smokers may respond more to external cues (e.g. smell of lit

cigarettes) such as those used in the cue exposure trials, whereas heavily dependent smokers may respond more to internal cues such as physiologic withdrawal symptoms (Herman, 1974; Vollstädt-Klein et al., 2011).

Average Cigarettes Per Day

"Cigarettes per day" (CPD) confirmed that participants smoked enough to be considered heavy smokers and were eligible for the parent study. Going day-by-day, participants estimated the number of cigarettes they smoked on each day in the past week. The number of cigarettes smoked each day was averaged to calculate the CPD study data. Like FTND, CPD may also need to be statistically controlled for in order to assess the relationship between SPS and cue reactivity (i.e. urge strength following cue exposure).

Ethical Considerations of Participation

This study and the parent study were non-intrusive questionnaire-based, and task-oriented research studies. The studies did not involve medication, collection of biologic samples, or invasive physiologic monitoring. Participants were asked to complete a series of questionnaires to assess smoking history, current level of nicotine dependence, mood, social problem-solving (SPS), and demographics. Some of the questions were somewhat personal in nature, and participants were made aware of the nature of the questions before they decided to participant. To partially alleviate these concerns, and to ensure anonymity, all data was tied to participant identification numbers instead of their names,

and was kept in separate locked cabinets away from the named and signed consent forms. This study only required the addition of the SPSI-R:S, which takes about five to 15 minutes. In attempts to reduce participant time and attention burden, study questionnaires and tasks were limited to those most relevant to the research aims.

The cue exposure trials were non-threatening, and were explained in detail prior to the start of the trials. Participants were offered a chance to ask questions before starting. The trials included a five-minute relaxation session (aimed at promoting acclimation with the environment) and a five-minute cue exposure that started with audiotaped instructions for imaginal smoking, followed by in-vivo handling of smoking paraphernalia and a lit cigarette. Participants completed measures of urge and affective states immediately before and after the smoking cue exposure. Air ventilators were used at all times to reduce the amount of environmental tobacco smoke.

Because participants were required to maintain abstinence prior to the session, and were exposed to smoking triggers designed to elicit urge, participants may also have experienced unpleasant urges to smoke. To alleviate potential concerns about urges, participants were assured that they would receive support from smoking cessation counselors. Following the exposure session, participants were informed about the purpose of the exposure, and offered the chance to ask questions. Next, they received their first counseling session (as part of the parent study) that introduced them to the challenges of quitting, as well as how the program would help them develop strategies for minimizing and coping with urges and withdrawal.

Research Design and Analysis plan

This study was designed to test whether or not social problem-solving (SPS) is related to urge reactivity following smoking cue exposure. A cross-sectional, pre-post exposure design enables tests for hypothesized, between-subjects' differences in urge reactivity due to SPS and negative affect. Dependent (paired) t-tests were used to test for differences between pre and post-exposure urge, and pre and post-exposure negative affect to validate procedures. Bivariate correlations were used to estimate the degree of linear relationship between independent and dependent variables of interests. Multivariate linear regressions were planned to assess the unique and relative contributions of SPS, negative problem orientation (NPO), negative affect, nicotine dependence, average cigarettes per day, and gender on urge reactivity, and post-exposure urge.

However, when using imputed data, SPSS cannot calculate all regression parameter estimates in a pooled fashion. For example, if any of the imputed models fail to agree on which variables are entered, removed, or in what order, the model reports no pooled estimates. Forced block entry was used in the early stages of regression model building. Study hypotheses were tested on linear regression models based on coefficient sizes, total model fit, statistical significance, and effect sizes. Statistically significant coefficients suggest that the coefficient is more likely to truly deviate from zero. Models that produced greater B (standardized and unstandardized regression coefficients) are more accurately predicting a relationship between the variables. Subsequently, other estimates of model fit such as *F*, "r", "r-square", and "adjusted-r square" should be larger in models more accurately depicting the relationships between independent and dependent

variables.

Some authors advocate for the use of a p-value of .10, especially in hypothesis-driven exploratory studies with little immediate downside to false-positives. Multiple analyses were planned, which increases the risk for type I error. Thus, a Bonferroni-style adjustment to account for multiplicity of analyses was considered. However, others argue that, especially in theoretical and model building studies (i.e. this study), these adjustments are likely to eclipse meaningful relationships (Perneger, 1998). Therefore, to strike a balance between the need to minimize type I error,and the need to fully explore the data, the p-value was reduced to $\alpha = .05$. Given the results from other studies of SPS on health outcomes (McCormick et al., 2014; Nezu et al., 2008) small to moderate effect sizes (Cohen's $f^2 = .15$ to .30) were anticipated when correlating and regressing urge on SPS and negative affect. Models testing these study hypotheses may contain up to four or five variables (when including level of nicotine dependence, CPD, and gender). Though fewer variables may provide a better fitting model (most demographic variables were not related to different urge and negative affect. Using G*Power statistical power calculator (Faul, Erdfelder, Buchner, & Lang, 2009), a sample size of least 67 (with medium effect size) to 129 observations (with small effect size) were needed to adequately power the analyses (B = .80).

CHAPTER 7

DATA ANALYSES AND RESULTS

Data Cleaning and Exploration

Missing Data and Imputation

Data were analyzed in IBM SPSS version 22. One hundred and one participants met eligibility criteria, and completed the baseline interview and exposure session. Table 1 contains a list of missing data by variable.

Table 1

Missing Data (n = 101)

Measure or Variable Name	Missing N
SPSI-R:S	8
PANAS pre-exposure	9
PANAS post-exposure	6
QSU-Brief pre-exposure	3
QSU-Brief post-exposure	23
FTND	0
Average Cigarettes Per Day	3
Race	4
Marital Status	3
Education	3
Employment Status	3
Age	0

Less than 10 missing data points were due to research assistant error. The majority of missing data (e.g. 23 missing QSU-Brief, and 8 missing SPSI-R:S) were missing because the questionnaires were added to the approved protocol partway through the parent study. There is no variable (measured or unmeasured) that is related to the time at which any given participant entered the study. In other words, people who joined the research program in the beginning of the study should not be any different from people who entered the study later. That being the case, this data can be said to be missing completely at random, and therefore, the cause of their non-response is ignorable, and this data is a good candidate for replacing missing values through imputation (Osborne, 2013; Schafer, 1999; Sterne et al., 2009).

In order to fill gaps in missing data and maximize sample size, multiple imputations were conducted using SPSS 22. The SPSS Missing Values add-on uses a Markov chain Monte Carlo algorithm. These algorithms consist of a chain of regression equations that use the existing data to create predictions about the missing data (Schafer, 1999). Multiple imputations are averaged to create a pooled estimate of the missing values. The validity and accuracy of the imputed data are improved over other methods (e.g. substituting missing data with the mean) because imputed data are drawn from subsamples of the actual data and the characteristics of the distribution of the existing data are carried over into the estimated values. Through multiple iterations the estimated values based on the imputed data become more representative of the original data (Andrieu, De Freitas, Doucet, & Jordan, 2003).

All variables, except participant identification numbers, were entered into the imputation model in SPSS. Twenty-five imputations were conducted with a maximum of 500 case draws, and 200 parameter draws. The minimum and maximum imputed values were constrained based on each assessment. For example, the QSU-Brief produces integers values zero to 60, so the imputed values should not be outside that range, nor should they have decimals. The missing values were imputed, and a separate data set was saved. SPSS, during analysis of imputed datasets, creates models on each imputation, and pools the estimates produced by each model (Enders, 2010). SPSS is capable of bivariate correlations, *t*-tests, and linear regression analyses on imputed data sets. However, some model parameters (e.g. r-squared, standard deviations, and regression *F* statistics) are not pooled by SPSS. These parameters were calculated on the original data set (with missing values and list-wise deletion).

Assumptions and Normality Testing

The analysis plan included parametric *t*-tests, bivariate correlations and linear regressions. The data must therefore be continuous, interval, independent, normally distributed, and exhibit homogeneity of variance (Field, 2005). Histograms, Q-Q plots, box plots, and residual plots for regression analyses were charted to visually discern level of normal distribution and identify potential outliers in the data. Variables subject to these assumptions include the social problem-solving (SPS) composite scores and subscale scores negative problem orientation (NPO) and impulsive-careless problem-solving (ICS), the PANAS, QSU-Brief, FTND, and cigarettes per day.

Numerical normality testing through Shapiro-Wilks tests has been recommended over the Kolmogorov-Smirnov test given the sample size is less than 200 (Field, 2005; Ghasemi & Zahediasl, 2012). Perfectly normal distributions are not always necessary for valid interpretation of parametric analyses. With a sample size of greater than 40, as in this study, a violation of normality assumptions based numerical tests (e.g. Shapiro-Wilks) may not preclude analyses or interpretation of results, especially if the data exhibit normality of distribution through other means of inspection (e.g. via histogram) (Ghasemi & Zahediasl, 2012). To further ensure validity of statistical inferences, any models that achieve significance will be explored through normality testing of the model residuals; greater normality of residuals represents better model fit, and an appropriate application of a regression.

The data exploration identified two possible outliers, one FTND score, and one negative affect score. Upon further inspection these values were deemed legitimate and realistic. Therefore, they were included in the analyses. In general, this data exhibited substantial variability and relatively normal distributions. See Appendix P for normality plots. The NPO subscale data exhibited some positive skew. However, no skew or kurtosis values were less than -2 or greater than 2, so skew should not be a major deterrent to valid inference (Burdenski, 2000; Field, 2005).

Results

Sample Characteristics

Table 2 contains the sample demographic characteristics. The sample had a mean

age of 41.21 years (sd = 10.93). Equal amounts of men and women were included as part of the parent study. Table 3 contains means and standard deviations for all variables of interest.

Table 2

Sample Characteristics of 101 Treatment-Seeking Smokers

Variable Name	%
Gender	
Male	50.5%
Female	49.5%
Race or Ethnicity	
Black or African American	77.2%
White or Caucasian	12.9%
Other or more than one race	5.9%
Missing	4.0%
Income	
Below poverty line	55.4%
At or above poverty line	38.6%
Missing	6.0%
Education level	
Some high school or less	14.9%
High school diploma or GED	42.6%
Vocational school or some college	28.7%
Graduated college or more	10.9%
Missing	2.9%
Employment status	
Unemployed	62.4%
Part-time	10.9%
Full-time	23.8%
Missing	2.9%
Marital status	
Single or never married	76.2%
Married/living with partner	9.9%
Widowed, divorced or separated	10.9%
Missing	3.0%

Table 3

Means and Standard Deviations (n = 101)

Variable Name	M	SD
Fagerstrom Test of Nicotine Dependence	5.27 (5.27)	1.26
Cigarettes per day (previous 7 days)	12.48 (12.42)	5.74
Social Problem-Solving Inventory: Revised Short form		
Social problem-solving composite	13.28 (13.3)	2.97
Negative problem orientation subscale	6.33 (6.34)	4.84
Impulsive-careless style subscale	6.67 (6.70)	4.15
Positive and Negative Affect Scale		
Pre-exposure negative affect	14.21 (14.41)	5.31
Post-exposure negative affect	15.80 (16.16)	7.93
Increase in negative affect	1.40 (1.74)	5.01
Questionnaire for Smoking Urges-Brief		
Pre-exposure	37.29 (37.48)	16.01
Post-exposure	45.83 (44.66)	16.61
Increase in urge	7.41 (7.18)	13.53

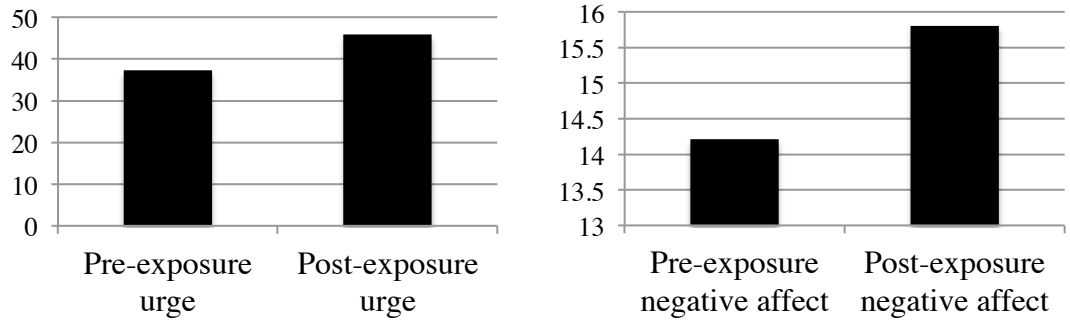
Notes: Values in parentheses are estimates based on imputed data. Non-imputed values are based on original data with list-wise deletion. Standard deviations based on imputed data are not produced by SPSS.

Cue Reactivity Manipulation Check

Cue reactivity was operationalized as post-exposure self-reported strength of urge. To verify that the exposure procedures successfully elicited cue reactivity, paired samples *t*-tests were conducted to compare pre and post-exposure smoking urges (as measured by the QSU-Brief), as well as pre and post-exposure negative affect (negative affect scale on the PANAS). Seventy-two percent of QSU-Brief scores increased from pre to post-exposure, 20% decreased after exposure, and 8% did not change. Levels of smoking urge

were significantly higher at post-exposure than pre-exposure ($t(1373) = -4.95$, $p < .001$). See Figure 1.

Figure 1. Pre and Post-Exposure Smoking Urges and Negative Affect



Refer back to Table 2 for the sample pre and post-exposure PANAS negative affect scale means, standard deviations, and change scores, and refer to Figure 1 for pre-exposure and post-exposure bar charts. The mean negative affect significantly increased from the time immediately after the relaxation trial (pre-smoking cue exposure) to after the cue exposure; $t(1832) = -3.02$, $p < .01$.

Bivariate Correlations

Table 4 presents bivariate correlations between SPS scores, increases in negative affect, post-exposure QSU-Brief scores, FTND, and CPD.

Table 4

Pearson's Bivariate Correlations

	SPS	NPO	ICS	NA	QSU	FTND	CPD
SPS	1	--	--	--	--		
NPO	-.73**	1	--	--	--		
ICS	-.74**	.63**	1	--	--		
NA	-.10	.23*	.16	1	--		
QSU	-.19	.08	.22*	.24*	1		
FTND	-.15	.13	.19	.11	.18	1	
CPD	.04	-.20	.00	-.09	.24*	.58**	1

* Correlation is significant at the .05 level (2-tailed).
** Correlation is significant at the .01 level (2-tailed).
Note: SPS Social problem-solving composite, NPO: Negative problem orientation, ICS: impulsive-careless problem-solving style, NA: negative affect, QSU: Questionnaire for Smoking Urges: Brief, FTND: Fagerstrom Test for Nicotine Dependence, CPD: Average cigarettes per day in the past week.

Scatter Plots Aim 1 Hypothesis 1 and 2

Scatter plots of Aim 1 independent variables (SPS composite, and NPO subscale) against the dependent variable (post-exposure urge strength) can be found in Appendix G. The plots reveal a very broad scatter and no discernable linear relationship between the independent and dependent variables. The scatter plots illustrate that pre-post exposure urges and negative affect varied greatly across the full range of SPS composite and NPO scores.

Aim 1 Hypothesis 1 Results

Aim 1 Hypothesis 1 predicted an inverse relationship between social problem-solving (SPSI:R-S composite scores) and post-exposure smoking urge strength (QSU-Brief scores). The bivariate correlation demonstrated a trend in the predicted direction but

did not reach statistical significance (r(101) = -.19, p = .085). Next, multiple regressions were used to test if SPS significantly predicted post-exposure urge scores while also accounting for nicotine dependence and cigarettes per day.

SPS composite alone (Model A) accounted for less than 3% of the variance; R^2 = .027, $F(1,73) = 2.03$, p = .16. It was found that the SPS composite scores did not significantly predict strength of urge to smoke (B = -1.00, p < .16). According to the unstandardized beta coefficient: one point lower on the 0-20 SPS composite scale predicted a score one point higher on the 0-60 point QSU-Brief.

Table 5

Regression of Urge on Social Problem-Solving, Aim 1 Hypothesis 1

Model Variable	B	Adjusted R square[a]	*F* (df)[a]
Model A		.01	2.03 (1,73)
Constant	58.60		
SPS composite	-1.05		
Model B		.04	2.48 (2, 72)
Constant	46.79		
SPS composite	-.92		
Nicotine dependence	1.93		
Model C		.12	5.82 (2, 72)**
Constant	50.76		
SPS composite	-1.10		
Cigarettes per day	.69*		

* Significant at .05 level.
** Significant at .01 level.
a. Based on the original available data (with missing data deleted list-wise, n = 74).

A model with social problem-solving and nicotine dependence (Model B) did not significantly predict urge. However, FTND appeared to add to the model's ability to predict urge scores as evidenced by increases in adjusted R-square and *F* from Model A to B. In Model C, a one cigarette per day increase (B = 1.03) was associated with about one point increase in QSU-Brief scores: this relationship was statistically significant. When comparing model A and model C, this data suggest that accounting for the number of cigarettes smoked per day does not inhibit or enhance the ability of SPS to predict urge strength. In all Aim 1 Hypothesis 1 models, the SPS-urge relationship was non-significant but in the hypothesized direction.

Aim 1 Hypothesis 2 Results

Aim 1 Hypothesis 2 predicted a positive relationship between NPO subscale and QSU-Brief post scores. Results of the bivariate correlation revealed no linear relationship, $r(101) = .08$, $p = .43$. See Table 6 for regression models with NPO, nicotine dependence, and cigarettes per day. In Model D, NPO alone accounted for essentially none of the variance ($R^2 = .004$, $F(1,73) = .26$, $p = .61$) and NPO did not significantly predict strength of urge to smoke ($B = .22$, $p < .61$).

Table 6

Regression of Urge on Negative Problem Orientation, Aim 1 Hypothesis 2

Model Variable	B	Adjusted R square[a]	*F* (df)[a]
Model D		-.01	.26 (1, 73)
Constant	42.85		
NPO	.29		
Model E		.02	1.85 (2, 72)
Constant	31.99		
NPO	.21		
FTND	2.15		
Model F		.09	4.92 (2, 72)*
Constant	32.53		
NPO	.46		
Cigarettes per day	.74*		

* Significant at .05 level.
** Significant at .01 level.
a. Based on the original available data (with missing data deleted list-wise).

A model with negative problem orientation and nicotine dependence (Model E) also failed to produce significant predictive relationships with urge strength. As in Hypothesis 1, cigarettes per day emerged as a statistically significant predictor (B = 1.06, p = .003). With cigarettes per day in the model, negative problem orientation became a slightly stronger predictor of urge strength, but the association did not reach statistical significance (B = .37, p = .38).

Aim 2 Hypothesis 1 Results

Aim 2 tests the hypothesis that negative affect mediates the association between NPO and post-exposure urge strength. For mediation to be present, it should be true that a

relationship exists between the independent variable (NPO scores) and the dependent variable (smoking urge strength). As seen in the scatterplots, bivariate correlations, and regressions from Aim 1 Hypothesis 2 analyses, NPO scores did not significantly predict urge strength.

Aim 2 Hypothesis 2 Results

Aim 2 Hypothesis 2 is designed to test the second assumption for this aim: the predictor (NPO) and the mediator (negative affect) are positively correlated. NPO and negative affect were significantly correlated in the hypothesized direction ($r(101) = .23$, $p = .012$). In regression models with nicotine dependence and cigarettes per day (Table 7), NPO scores remained a significant predictor of increases in negative affect from pre to post exposure. While NPO was a significant predictor of post minus pre-exposure negative affect, overall model variance associated with the dependent variable did not reach statistical significance. See *F*-values in Table 7. Neither cigarettes per day nor FTND were significant predictors of negative affect.

Table 7

Regression of Negative Affect on Negative Problem Orientation, Aim 2 Hypothesis 2

Model Variable	B	Adjusted R square[a]	*F* (df)[a]
Model G		-.006	.49 (1, 80)
Constant	.04		
NPO	.27*		
Model H		-.012	.52 (2, 79)
Constant	-1.73		
NPO	.26*		
FTND	.35		
Model I		-.02	.21 (2, 78)
Constant	.64		
NPO	.26*		
Cigarettes per day	-.04		

* Significant at .05 level.
** Significant at .01 level.
a. Based on the original available data (with missing data deleted list-wise).

Aim 2 Hypothesis 3 Results

Aim 2 Hypothesis 3 assumes that negative affect is positively correlated with urge. This relationship reached statistical significance in multiple regressions (see Table 8). With nicotine dependence and cigarettes per day in the model, increases in negative affect scores from pre to post were a significant predictor of urge strength following cue exposure.

Table 8

Regression of Urge on Negative Affect (NA), Aim 2 Hypothesis 3

Model Variable	B	Adjusted R square[a]	*F* (df)[a]
Model J		.023	2.59 (1, 67)
Constant	43.45		
Negative affect	.69*		
Model K		.045	2.60 (2, 66)
Constant	33.27		
Negative affect	.65*		
FTND	1.95		
Model L		.15	6.76 (2, 66)**
Constant	34.23		
Negative affect	.77**		
Cigarettes per day	.73*		

* Significant at .05 level.
** Significant at .01 level.
a. Based on the original available data (with missing data deleted list-wise).

Aim 2 Mediation Results

The main hypothesis of Aim 2 is that negative affect mediates the relationship. A Sobel test was used to test significance of a mediation effect. From the regression models, NPO predicts post minus pre-exposure negative affect with $B_a = .27$ ($SE_a = .12$) and post minus pre-exposure negative affect changes predict smoking urge with $B_b = .69$ ($SE_b = .30$). These values were entered into the online Sobel test statistic calculator found at http://quantpsy.org/sobel/sobel.htm (Hayes, 2009) which produced a Sobel test statistic of 1.61, which demonstrated a rend in the hypothesized direction, but did not reach significance ($p = .11$).

Aim 3 Hypothesis 1 Results

Aim 3 Hypothesis 1 analyses tested if gender was a moderator of the NPO-urge relationship. Testing this hypothesis required that NPO be correlated with urge reactivity under some circumstances. For example, the correlation may be stronger among women in comparison to men. However, not only was NPO not related to urge reactivity, but this relationship was not observed to be different across genders.

Gender Comparisons

Strength of smoking urge as measured by the QSU-brief scores was equivalent between men (M = 46.26, SD = 16.95) and women (M = 45.33, SD = 16.44), $t(76) = .25$, p = .81. Likewise, post minus pre-exposure negative affect did not significantly differ between men (M = .93, SD = 4.26) and women (M =1.8, SD = 5.58), $t(898) = .04$, p = .97. Moreover, there was no gender difference in SPS composite scores: $t(99) = .90$, p = .37, NPO subscale scores: $t(99) = -.30$, p = .76, or ICS subscale scores, $t(99) = -.30$, p = .76.

Aim 3 Hypothesis 1 Regressions

Multiple regression model comparisons were used to explore a possible NPO-urge effect moderated by gender. To test for interactions, gender (designated as "0" for men and "1" for women) was entered in Models M with NPO, and with an interaction term "gender * NPO" in Model N. Because nicotine dependence had not yet been a significant predictor in any models it was left out of the Aim 3 hypotheses tests.

To indicate moderation, a model with the interaction term should increase the adjusted r-square indicating a more predictive model than without the interaction. However, the interaction term did not reach significance, and therefore, did not evidence a moderating effect of gender. Although, gender itself became a larger, though non-significant predictor of urge when the gender*NPO term was included (Model N).

Table 9

Regression of Urge on Negative Problem Orientation and Gender, Aim 3 Hypothesis 1

Model Variable	B	Adjusted R square[a]	*F* (df)[a]
Model M		.083	3.24 (3, 71)*
Constant	32.42		
NPO	.46		
Gender	.22		
Cigarettes per day	.74*		
Model N		.090	3.24 (3, 71)*
Constant	35.20		
NPO	-.009		
Gender	-5.63		
Cigarettes per day	.74*		
Gender * NPO	.92		

* Significant at .05 level.
** Significant at .01 level.
a. Based on the original available data (with missing data deleted list-wise).

Aim 3 Hypothesis 2 Results

Aim 3 Hypothesis 2 analyses tested if impulsivity (ICS) is a moderator of the NPO-urge relationship. As previously presented, a negative problem orientation-urge relationship was not observed in this data. See Table 10 for ICS and NPO interaction models predicting urge strength. The ICS * NPO interaction term was non-significant.

Table 10

Regression of Urge on Impulsivity, Negative Problem Orientation, and Negative Affect Aim 3 Hypothesis 2

Model Variable	B	Adjusted R square[a]	*F* (df)[a]
Model O		.093	3.54 (3, 71)*
Constant	30.65		
ICS	.90		
NPO	-.04		
Cigarettes per day	.66*		
Model P		.11	3.17 (4, 70)*
Constant	34.04		
ICS	.34		
NPO	-.66		
Cigarettes per day	.66*		
ICS * NPO	.08		
Model Q		.13	3.42 (4, 62)*
Constant	30.26		
ICS	.87		
NPO	-.20		
Cigarettes per day	.69*		
Negative affect	.70*		
Model R		.01	1.24 (3, 63)
Constant	39.32		
ICS	1.06*		
NPO	-.46		
Negative affect	.66*		

* Significant at .05 level.
** Significant at .01 level.
a. Based on the original available data (with missing data deleted list-wise).

Lastly, two additional exploratory regressions were conducted in which negative affect was added to the ICS-NPO models predicting strength of urge (one with "cigarettes per day" (Model Q) and one without (Model R). As in previous models, SPS factors, in

the case of all models in Table 10, did not strongly predict urge strength. Negative affect, as in previous models, emerged as a significant predictor of urge (Models Q and R). In Model R, CPD was removed and the predictive power of negative affect remained unchanged, and impulsivity (ICS) became a slightly stronger, and statistically significant predictor of urge.

CHAPTER 8

DISCUSSION

Summary of Findings

Smokers with the highest risk for relapse are those who smoke to cope with stress and other unpleasant states (i.e. negative affect) (O'Connell & Shiffman, 1988; Shiffman & Gwaltney, 2008). To examine stress and affect-related relapse risk, it was hypothesized that exposure to smoking cues would elicit stronger urges in smokers who reported the tendency to use maladaptive problem-solving approaches such as negative problem orientation and impulsive-careless problem-solving. There was a lack of significant association between social problem-solving factors and smoking urge strength. The lack of significance was unlikely to have been caused by the ineffectiveness of the cue exposure to elicit urge and reactivity.

The study participants were heavy smokers who were sedentary. However, in order to be eligible for the cue exposure session, they were required to be bioverified abstinent for at least two to three hours. Comparisons of pre and post-cue exposure urge strength revealed a significant increase in mean strength of urge. Mean negative affect also increased from pre to post exposure. These increases suggest that a single cue exposure trial was effective in eliciting both smoking urge and negative affect-related cue reactivity. However, overall social problem-solving, negative problem orientation, or impulsive-careless problem-solving style individual differences did not predict post-exposure urge. Importantly, participants with a greater negative problem orientation showed prominent increases in negative affect, a key risk factor for relapse, and barrier to

extinction of cue reactivity (Collins et al., 2011). These results suggest that preventing heavy smokers from smoking in the presence of conditioned smoking cues is more likely to produce result in negative affect among smokers with a greater negative problem orientation, who feel more often threatened and overwhelmed by problems. Previous research indicates that relapse may be more common among women because of a greater chance of experiencing depressive, anxiety, and other stress-related disorders (Buckner & Vinci, 2013; Reynoso, Susabda, & Cepeda-Benito, 2005), stronger negative affect, and stronger cue-induced urges (Collins et al., 2011; Reynoso, Susabda, & Cepeda-Benito, 2005; Robinson et al., 2007). Yet, the data from this study do not indicate gender differences in nicotine dependence, social problem-solving, urge strength, or negative affect.

Aim 1 Discussion

Neither SPS composite scores nor NPO scores were significant predictors of smoking urge strength following cue exposure. Nicotine dependence was not a significant predictor of urge strength. However, the average number of cigarettes per day was a significant predictor of urge strength and was included in subsequent regression models. FTND may not have been a significant predictor because of previous findings that heavy smokers (such as those in this study) respond more to interoceptive and psychological cues (e.g. stress) (Herman, 1974; Vollstädt-Klein et al., 2011). This study featured smoking-related cues.

Adding SPS or NPO to the model with cigarettes per day did not significantly

improve model fit or the amount of variability in urge accounted for. Because this is the first study to attempt to predict smoking urges with social problem-solving it is difficult to know whether the lack of significant prediction was due to measurement error, an underpowered analysis, or a real lack of connection between SPS and smoking urge strength (during lab-based cue exposures).

The lack of correlation between SPS, NPO, and urge may be due to the fact that SPS and NPO, as measured by the SPSI-R:S, are not active during cue exposures. For example, someone who reports a more NPO may not actually be engaging in those tendencies during cue exposure and therefore NPO does not have an influence on urge. The cue exposure may also be different from other normal experiences in which SPS is actively influencing physiological and behavioral outcomes. The cue exposure is part of a novel context in which the participants were required to find a new building, locate an office, meet researchers and counselors (who are strangers to them), complete a large number of questionnaires, and engage in a slightly novel cue exposure task. Any number of these aspects of the lab visit could influence the problem-solving and coping participants employed during the cue exposure (Drobes, Meier, & Tiffany, 1994). However, SPS, by its nature describes a person's response to potentially complex, and novel situations, challenges or problems. Certainly the cue exposure task exhibits these characteristics, as does quitting smoking in general. In other words, SPS factors, theoretically and conceptually, should have been related to cue exposure-related outcomes (e.g. change in urge to smoke) but the data did not bear out these relationships.

Aim 2 Discussion

Aim 2 was designed to test the hypothesis that negative affect mediates the association between NPO and post-exposure urge strength. The first hypothesis in this aim tests the relationship between NPO and urge strength. This relationship was not observed. Second, a relationship between NPO and negative affect must be observed. This relationship did reach statistical significance. NPO was positively correlated with larger increases in negative affect during the cue exposure trial. In other words, people who report feeling overwhelmed by challenges in life, and getting frustrated during stressful times also showed the most prominent cue-induced negative affect, a key risk factor for relapse (Collins et al., 2011).

Lastly, for mediation to be occurring, a relationship between negative affect and urge must also have been observed. This relationship was also statistically significant; greater increases in pre to post exposure negative affect were correlated with stronger smoking urges. This data align with other research showing that negative affect during cue exposure is associated with stronger reactivity to smoking cues (Collins et al., 2011; Saladin & Gray, 2012). A Sobel test for mediation did not reach statistical significance; this data does not suggest that negative affective mediates an association between NPO and smoking urges.

However, higher levels of NPO significantly predicted greater increases negative affect, and negative affect increases predicted urge. Lack of mediation could be due to the fact that NPO and negative affect are co-linear, are tapping the same constructs. Theoretically, NPO should predict negative affect as a product of the appraisal and SPS

process that occurs when a person is faced with a stressor. Negative affect should lie along the pathway from negative problem orientation and urge. The apparent lack of relationship between NPO and urge while 1) NPO significantly predicts negative affect and 2) negative affect predicts urge suggest that other factors (i.e. gender or impulsivity) could be moderating the NPO-urge relationship. These factors were explored in Aim 3. The sign of a relationship between NPO and negative affect is promising because it lends credence to the theory that smokers with NPO experience more negative affect.

This data provide limited evidence that NPO (and potentially other emotion-focused coping, and self-efficacy-related constructs) act as relapse risk factors through negative affective modulation of cue reactivity. Because the sample (sedentary smokers) exhibited greater NPO levels than the normative sample (D'Zurilla et al., 2002), it is possible that 1) people who fail to develop and engage in adaptive problem-solving styles are more likely to start smoking, and 2) smoking, as it becomes a habit, prevents people from engaging in other, potentially more adaptive strategies. Smoking, may, overtime, degrade the quality of problem-solving strategies employed, and similarly degrade other relapse-preventing cognitive factors (e.g. self-efficacy, internal locus of control).

Aim 3 Discussion

Aim 3 was designed to test potential moderators of the relationship between NPO and urge reactivity: gender and impulsivity. This data did not indicate gender differences in NPO, unlike D'Zurilla and colleagues (D'Zurilla, Maydeu-Olivares, & Kant, 1998) who found that women had higher levels of NPO in comparison to men. Gender was hypothesized to moderate the NPO-urge reactivity relationship because previous research

suggests that, in comparison to men, women smoke more to deal with negative affect. This aim could not be fully explored due to the lack of statistical relationship between NPO and urge. Women exhibited higher post-exposure negative affect than men to a statistically significant degree. Regression predicting urge strength failed to produce statistically significant regression coefficients for NPO, gender, or an NPO-gender interaction term. These results stand in contrast to previous research that found that women had a lower probability of above average urge at all time points in a multiple trial cue exposure session in comparison to men (Collins et al., 2011). However, like Collins et al (2011), negative affect was associated with stronger urges.

In this data, urge reactivity significantly varied by level of impulsive-careless problem-solving style. Previous research has found no relationship between self-report measures of impulsivity and cue reactivity (Doran, Cook, McChargue, & Spring, 2009; Salgado-García, Cooper, & Taylor, 2013). In regression models, impulsive-careless problem-solving styles and negative problem orientation, and the interaction term failed to significantly predict urge strength. However, in a final model, negative affect was added and emerged a significant predictor of urge along with level of impulsive-careless problem-solving style. These models suggest that bioverified abstinent smokers who tend to be more impulsive when coping with stressors also experienced stronger smoking urges and greater increases in negative affect during exposure to highly-salient smoking cues in a situation in which smoking is not allowed.

Limitations

This study was cross-sectional in nature and therefore the analyses were limited in terms of ability to ascertain cause and effect. But, social problem-solving (SPS) was assessed prior to cue exposures, so the associations between SPS and cue reactivity could be interpreted as SPS factors influencing reactivity, rather than the other way around. At the same time, it may have been more useful, given the research aims, to measure SPS after the cue exposure, when the participants are experiencing higher urges and negative affect. SPS, while relatively stable, can change. Smokers might have responded differently to the same questions assessing their SPS had it been administered on their quit day. People may have entered the study feeling optimistic, upbeat, motivated and with a positive perspective on their problem-solving. But on their quit day they may feel differently about their ability to stay quit, and manage stress without smoking.

There is evidence that urge, negative affect, and withdrawal states cause people to use different coping skills (Drobes et al., 1994). Perhaps SPS data collected after the cue exposure would be more indicative of how these people would respond in high-urge, high-risk situations. However, participants had already been abstinent for at least couple hours and were already experiencing urges, and negative affect (as evidenced by considerable urge strength and negative affect prior to cue exposure).

Another potential limitation to this study lies in the fact that the data were collected one month before the start of the participant's quit attempt. The answers on the SPS questionnaire may not represent how someone will actually respond to stressors after they quit smoking. Because the challenge of quitting was not immediately in front of them,

smokers would not felt the same pressure during the cue exposures, limiting the extent to which they experienced negative affect and urges. SPS, affect, and cue reactivity measured at the onset of a quit attempt, and at multiple points during the quit attempt may be more helpful in modeling the influences of stress, affect, and urges on relapse risk.

Another potential limitation with this study was the fact that smokers were required to achieve only minimal levels of abstinence prior to entering the cue exposure session. Longer abstinence would have elicited strong post-exposure urge and negative affect (Brown et al., 2013; John R Hughes, 2007; K. a. Perkins, Grobe, Weiss, Fonte, & Caggiula, 1996). The investigators implemented this approach in order to retain participants who otherwise might decide not to join the program, or miss their appointment because staying smoke-free for more than a few hours their appointment would be too difficult. However, requiring smokers to achieve a greater degree of abstinence could have helped amplify the effects of the cue exposure on urge strength and negative affect. These models would, in turn, have a greater chance of capturing associations between SPS, and cue-induced urge and negative affect.

The theory, study, and research design are further limited by the fact that cue reactivity is not a perfectly linear phenomenon. The data here demonstrate that not all participants exhibited increases in urge following cue exposure trials; in fact, some exhibited no change or decreases in urge. Though, the mean urge was significantly higher at post in comparison to pre-exposure. It could be argued that SPS would serve as a

buffer against urges increasing, but it is more difficult to imagine smokers with high levels of adaptive SPS, or low levels of maladaptive SPS (e.g. low NPO) experiencing decreases in urge during a cue exposure after all, they are nicotine-deprived and being presented with highly-salient smoking-related stimuli). Had this phenomenon been realized in the data, the linear relationships between SPS (or NPO) and urge may have materialized more clearly. However, as the scatter plots revealed, scores varied across all scales. Participants with very maladaptive SPS and NPO experienced decreases in urge and negative affect, and participants with high degrees of adaptive SPS experienced increases in urge and negative affect. The scattered data suggests the increase in urge from pre to post-exposure that would have been correlated with SPS, or NPO has only the potential to operate among participants who exhibited increases in urge reactivity. This characteristic of the data may have reduced the chances of detecting the hypothesized relationship between SPS and urge.

This study was also limited because it was based on self-report questionnaires, and does not allow for examination of the underlying biological mechanisms. For example, the findings cannot address hypotheses about whether or not SPS factors are differentially linked to the physiological conditioned responses to smoking cues (e.g. cortisol increase, autonomic nervous system reactivity). The relationship between SPS (and any coping framework) and cue reactivity is complex. Some smokers might exhibit cue reactivity, but not through self-report urge. It is possible that SPS was linked to cue reactivity but only on unmeasured aspects such as the fluctuations in autonomic functioning that have been observed in other reactivity studies (Chae et al., 2008; Payne et al., 1996; Payne et

al., 2006). Complimenting self-report reactivity, with a measure of physiology, or smoking topography would allow for more complex modeling of SPS and cue reactivity.

Another potential limitation in such a research design is that the context in which these cues were presented (a laboratory, experimental room) is somewhat unlike the contexts in which the associations between smoking cues and urges originally formed. A number of studies have highlighted the importance of context in terms of the elicitation of conditioned responses (Bouton & King, 1983; Bouton, 2004; Collins & Brandon, 2002; Mineka, Mystkowski, Hladek, & Rodriguez, 1999; Powell, 1995). Future cue exposure treatment interventions may need to be altered so that they can be applied in real world, in everyday contexts. That said, using an experimentally controlled setting allows for specific research questions to be systematically addressed in ways that may not be possible outside the lab.

Internal Validity of Findings

The internal validity of this study stems primarily from the psychometric assessments of smoking urge, negative affect, and social problem-solving that have been previously validated and found to accurately and reliably assess the characteristics they are intended to measure. The QSU-Brief has been used and validated in previous research with similar designs as this study (Cox et al., 2001; Littel, Franken, & Muris, n.d.;. Watson, Carpenter, Saladin, Gray, & Upadhyaya, 2010; West & Ussher, 2010). Even though the SPSI-R:S has not been extensively used in studies with smokers it has been used and validated across a variety of demographic groups (D'Zurilla et al., 2002).

Internal validity of the statistical associations in this study is bolstered by the fact the relationships remained significant in models that accounted for level of nicotine dependence and number of cigarettes per day. The extent to which urges gained strength during the exposure may have been caused in part by the nicotine-dependence-related factors. Controlling for these variables allowed for a more direct assessment of the strength of the relationships tested in the study hypotheses. Likewise, there were no differences in SPS, affect, or urge strength based on gender, age, or any demographic variables. Therefore, the relationship between SPS, affect, and urge can be more confidently interpreted as being valid.

External Validity of Findings

This study enhanced external validity by using familiar smoking cues. Participants were exposed to the sight and smell of their own brand of cigarettes, along with imaginal exposures of inhaling the cigarette (though actual inhalation was disallowed during the trials). Using highly salient, multi-sensory cue exposure content should, through the hard-wired neurobiological conditioning substrates described earlier, elicit a reliable conditioned response similar to the responses emitted outside the lab.

The study also achieved high external validity in that smokers were required to be abstinence from nicotine and were therefore exposed to smoking cues in a state similar to how they will experience cues when they are attempting to quit smoking. Furthermore, participants completed the SPS measure during a state of abstinence. Because coping strategies can change given different mood states (Drobes et al., 1994), the fact that SPS

was measured during a nicotine withdrawal-like state may increase the extent to which the participants responses to questions about their social problem-solving reflect how they would actually respond to stressors during a cessation attempt (in a state of withdrawal). However, these smokers, while motivated to quit, were not yet in the quitting mindset. From the description of what study participation entailed, they knew they would not be expected to stay quit that day (quit days were assigned for one month after joining the Step Up to Quit program), and they could smoke after the session if they so chose. This knowledge (that smoking is an option) leads to a different psychological context which could in turn influence the extent to which smoking cues elicited negative affect or urges to smoke. Perceived availability of smoking has been found to differentially impact cue reactivity. Droungas and colleagues (1995) found that under conditions in which participants were told they would not be able to smoke, they experienced weaker urges in comparison to conditions in which they were told smoking would be an option. Although, another study found that perceived availability of smoking did not impact smoking urges or physiological cue reactivity (Field & Duka, 2004). However, smokers in Field and Duka (2004) study were minimally dependent and not required to be abstinent.

External Validity and Generalizability of the Sample

The study sample consisted primarily of heavily nicotine dependent, African American or Black, low-income smokers. The participants were also required to be physically inactive. The sample is representative of the sub-groups of smokers most in

need of cessation services: medically underserved, financially burdened by nicotine dependence, and more exposed to marketing and high-availability of tobacco, and those most susceptible to negative health effects from smoking. The sample also represents people from low-income communities in which high stress, low self-efficacy, and mental health issues are more common due to the socio-cultural influence of poverty. Therefore, the research conducted is this study is likely to be relevant to the needs of people seeking cessation services, especially, low-income, single, and sedentary smokers.

Future Research

This study did not find significant associations between social problem-solving and cue reactivity (as measured by post-exposure urge strength). However, smokers in this study exhibited higher levels of negative problem orientation and impulsive-careless style in comparison to the SPSI-R:S normative sample. This result suggests that treatment seeking, sedentary, nicotine-dependent smokers engage in less adaptive or effective responses to stress and life's challenges in comparison to the general population. The result also aligns with previous research showing that smokers who engage in more and adaptive strategies when managing stress and urges to smoke have a lower risk of relapse (Shiffman, Paty, Gnys, Kassel, & Hickcox, 1996; Shiffman, 1984). Reduction in relapse risk that relate to social problem-solving skills may stem from the fact that adaptive problem-solving 1) more often results in an effective solution and end to the stressor, 2) empowers use of stress or negative emotions to direct behavior towards the stressor, 3) increases tolerance and patience for unpleasant states and problem-solving (e.g. urges,

stress, negative affect), 4) increases self-efficacy about maintaining abstinence.

Additionally, there is the possibility that SPS impacts urges because it predicts amount of perceived stress, but also that SPS could determine the likelihood of urges actually resulting in smoking. Some smokers may only experience weak urges, but due to their inability to manage those sensations and create an alternative solution, they eventually lapse or relapse. At the same time, other smokers may experience very strong urges, but due to their positive problem orientation, are able to use the emotions to motivate them to abstain, or to try a different urge management strategy. Given that the study sample demonstrated significantly higher levels of negative problem orientation it could be expected that they would exhibit problem behaviors related to inability to manage negative emotions (e.g. smoking to cope). Studies that examined SPS factors in relation to likelihood of smoking and relapse while controlling for urge strength would shed light on the process by which urges becomes lapses, and relapses.

While social problem-solving scale scores may not be related to urge reactivity in this sample still help people manage urges, and predict reactivity-related relapse risk factors (e.g. stress, negative affect). Frameworks like SPS are useful in smoking research because they can assess the extent to which stress and negative affect are negative influences on health and behavior, contribute to urges, and increase the likelihood that urges to smoke actually lead to smoking. Future research should investigate how SPS, stress and negative affect determine urge strength and the nature of the responses to smoking urges (smoking and non-smoking coping responses).

It is also possible that SPS and cue reactivity are unrelated until urges become

strong enough to become a problem. For example, urge trajectory studies have shown that smoking urges increase during the first few trials (Collins et al., 2011). The first trial, which was the focus of the present study, may not have elicited an urge strong enough, or represented a large enough problem for people to engage in SPS. This would explain why SPS not related to level of cue reactivity in this study. The potential lag time prior to the onset of a relationship between coping and cue reactivity should be further researched. Measuring associations between SPS across multiple trials would offer more detailed insight into on-going, changing relationships between affect, smoking urges, and coping styles. For example, it is possible that depending the type of coping skills being used, smokers may exhibit different trajectories of urge extinction. As previous studies have found, affective variables are related to rate of decrease in urges over repeated trials. Similar research questions could be posed but with coping and problem-solving styles as the predictor of urge trajectories.

Cue exposure paradigms that purposefully elicit stress responses and negative affect through experimental manipulations could also shed light on the roles of SPS and cue reactivity in relapse. This study used a relaxation trial prior to the smoking cue exposure trial, but perhaps the relationship between SPS and urge reactivity is better observed through a study that explicitly elicits stress as part of the cue exposure trials. Other studies may need to experimentally elicit stress or negative affect, and monitor the cognitive-affective coping strategies but do so outside of the laboratory, in places where smoking urges lead to more natural smoking behavior. It is possible that SPS does not so much predict strength of urge, but instead the likelihood that a smoker succumbs to an

urge while they are trying to maintain abstinence. The gap between urge and smoking was not addressed in this study, but understanding the progression from conditioned stimulus, to urge, to smoking behavior may offer insights for research and intervention design.

Another potentially valuable line of research could involve assessing the relationship between coping and cue reactivity closer to the quit date. The way a smoker copes with stress, negative affect, and smoking urges could change depending on if they quit or not. The same variable may also impact rate of extinction. For example, cue exposure treatment (CET) procedures might achieve extinction more readily if the smoker does not feel the pressure of having to be quit permanently. Alternatively, CET might be more beneficial once a smoker has already begun their quit attempt. Applying CET later in the quitting process might make extinction effects more robust. Social problem-solving styles and other cognitive variables (e.g. self-efficacy) could fluctuate throughout a quit attempt. Measuring these cognitive-affective-behavioral variables at various time points during quit attempts could shed new light on the process by which smoking urges, stress, and negative affect produce relapse.

Summary

Social problem-solving describes the ability to accurately define problems, tolerate negative emotions during coping and problem-solving, be persistent and patient during stress, create and compare multiple approaches, and perceive ones' self as having self-efficacy, or being able to benefit from life's challenges. This study hypothesized that people without these skills may be more likely to experience strong urges and more

negative affective in response to highly salient smoking cues during a period of nicotine deprivation. While scores on an assessment of social problem-solving were not related to cue-elicited smoking urge, negative problem orientation was related to negative affect (an important factor in urge strength, relapse risk, and overall health and well-being). Negative affect and impulsive-careless problem-solving style were found to significantly predict urge strength. This study found no differences across genders, despite previous research evidencing differences in urge reactivity, cue-induced negative affect, and negative problem orientation.

This study was informed by the fact that every smoker has a different learning history, motivations for smoking, and strengths or weaknesses that influence their likelihood of relapse. Smoking cessation research is at the point where we can measure many of these factors. At the same time, researchers have struggled to translate this knowledge into more efficacious cessation programs. Integrating cue exposure and social problem-solving theories, as this study did, provides a number of potential advantages: 1) cue exposure content and manipulations (e.g. stress induction) in CET could challenge smokers in ways that more accurately alter the learning (and cue reactivity) most predictive of relapse, 2) measuring social problem-solving and cue-induced changes in urges and affect (e.g. Collins & Brandon, 2002; Collins et al., 2011; Conklin & Tiffany, 2002) offers a potentially valuable method for identifying modifiable predictors of relapse, and 3) helping smokers developing adaptive social problem-solving will have beneficial impacts across multiple health behaviors. Cue-based models are valuable tools for researching substance use, and helping users successfully change their behavior.

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APPENDIX A

DEMOGRAPHIC AND SCREENING QUESTIONNAIRE

1. Are you currently pregnant?

2. What is your age in years?

3. Gender?

4. How many cigarettes do you smoke per day, on average?

5. What brand of cigarettes do you smoke (please be specific)

6. We don't need to know exactly, but can you please tell me, before taxes, does your household make less than $11,722 (for household of 1 person), $15,730 (for households of 2 people), $19,790 (for households of 3 people), $23,850 (for households of 4 people), $27,910 (for households of 5 people), $31,970 (for households of 6 people), $36,030 (for households of 7 people), $40,0900 (for households of 8)?

   For households with more than 8 persons, add $4,060 for each additional person. (U.S. Department of Health and Human Services Poverty Guidelines, 2014).

7. Which of the following would you use to describe your race? White or Caucasian, Black or African American, Hispanic or Latino/Latina, American Indian or Alaskan Native, Asian or Pacific Islander, Other (please specify).

8. What best describes your marital status? (Single/never married, Married living with partner, Widowed/divorced/separated, Refuse to answer, 0, 1, 2, 3)

9. How far did you go in school? (Some high school or less, high school graduate or GED, vocational school or some college, college degree, above college degree, 0, 1, 2, 3, 4)

10. Are you currently employed? (No, Yes full-time, Yes half-time), 0, 1, 2)

APPENDIX B

POSITIVE AND NEGATIVE AFFECTIVE SCHEDULE

The PANAS consists of a number of words that describe different feelings and emotions. Read each item and then circle the appropriate answer next to that word. Indicate to what extent you have felt this way during the past week.

Use the following scale to record your answers.
(1) = Very slightly or not at all (2) = A little (3) = Moderately (4) = Quite a bit (5) = Extremely

	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Interested	1	2	3	4	5
Distressed	1	2	3	4	5
Excited	1	2	3	4	5
Upset	1	2	3	4	5
Strong	1	2	3	4	5
Guilty	1	2	3	4	5
Scared	1	2	3	4	5
Hostile	1	2	3	4	5
Enthusiastic	1	2	3	4	5
Proud	1	2	3	4	5
Irritable	1	2	3	4	5
Alert	1	2	3	4	5
Ashamed	1	2	3	4	5
Inspired	1	2	3	4	5
Nervous	1	2	3	4	5
Determined	1	2	3	4	5
Attentive	1	2	3	4	5
Jittery	1	2	3	4	5
Active	1	2	3	4	5
Afraid	1	2	3	4	5

APPENDIX C

FAGERSTROM TEST OF NICOTINE DEPENDENCE

1. How soon after you wake up do you smoke your first cigarette?
a) Within 5 minutes
b) 6-30 minutes
c) 31-60 minutes
d) After 60 minutes
e) Don't know

2. Do you find it difficult to refrain from smoking in places where it is forbidden, e.g. at (church), at the bus?
a) Yes
b) No
c) Don't know

3. Which cigarette would hate most to give up?
a) First one in the morning
b) All others
c) Don't know

4. How many cigarettes/day do you smoke?
a) 10 or less
b) 11-20
c) 31 or more
d) Don't know

5. Do you smoke more frequently during the first hours after waking than the rest of the day?
a) Yes
b) No
c) Don't know

6. Do you smoke when you are so ill that you are in bed most of the day?
a) Yes
b) No
c) Don't know

APPENDIX D

QUESTIONNAIRE FOR SMOKING URGES-BRIEF

Baseline PostRelaxation - Questionnaire for Smoking Urges

2. Indicate the extent to which you agree or disagree right now with each of the following statements

	Strongly Disagree						Strongly Agree
1) I have a desire to smoke right now	◯	◯	◯	◯	◯	◯	◯
2) Nothing would be better than smoking a cigarette right now	◯	◯	◯	◯	◯	◯	◯
3) If it were possible, I probably would smoke now	◯	◯	◯	◯	◯	◯	◯
4) I could control things better right now if I could smoke	◯	◯	◯	◯	◯	◯	◯
5) All I want right now is a cigarette	◯	◯	◯	◯	◯	◯	◯
6) I have an urge for a cigarette	◯	◯	◯	◯	◯	◯	◯
7) A cigarette would taste good now	◯	◯	◯	◯	◯	◯	◯
8) I would do almost anything for a cigarette now	◯	◯	◯	◯	◯	◯	◯
9) Smoking would make me less depressed	◯	◯	◯	◯	◯	◯	◯
10) I am going to smoke as	◯	◯	◯	◯	◯	◯	◯

Note: Baseline Post Relaxation– Questionnaire for Smoking Urges, this measure, is referred to as the pre-exposure urge level in the text.

APPENDIX E

SOCIAL PROBLEM-SOLVING INVENTORY-REVISED: SHORT FORM

Note: the SPSI-R:S is a licensed measure that should not be duplicated or used without the appropriate purchased copies.

Thomas J. D'Zurilla, Ph.D., Arthur M. Nezu, Ph.D., & Albert Maydeu-Olivares, Ph.D.

Instructions: Below are some ways that you might think, feel, and act when faced with problems in everyday living. We are not talking about the ordinary hassles and pressures that you handle successfully ever day. In this questionnaire, a problem is something important in your life that bothers you a lot, but you don't immediately know how to make it better or to stop it from bothering you so much. The problem could be something about yourself (such as your thoughts feelings, behaviors, health, or appearance), your relationships with other people (such as your family, friends, teachers, or boss), or your environment and things you own (such as your house, car, property, or money). Please read each statement carefully and choose one of the numbers below that best shows how much the statement is true of you. See yourself as you usually think, feel, and act when you are faced with important problems in your life these days. Circle the number that is the most true of you. Do not erase if you want to change an answer, instead put an "X" through the answer you wish to change. Try to answer all of the questions.

	Not at all true of me (0)	Slightly true of me (1)	Moderately true of me (2)	Very true of me (3)	Extremely true of me (4)
1. I feel threatened and afraid when I have an important problem to solve.	0	1	2	3	4
2. When making decisions, I do not evaluate all my options carefully enough.	0	1	2	3	4
3. I feel nervous and unsure of	0	1	2	3	4

myself when I have an important decision to make.					
4. When my first efforts to solve a problem fail, I know if I persist and do not give up too easily, I will be able to eventually find a good solution.	0	1	2	3	4
5. When I have a problem, I try to see it as a challenge, or opportunity to benefit in some positive way from having the problem.	0	1	2	3	4
6. I wait to see if a problem will resolve itself first before trying to solve it myself.	0	1	2	3	4
7. When my first efforts to solve a problem fail, I get very frustrated.	0	1	2	3	4
8. When I am	0	1	2	3	4

faced with a difficult problem, I doubt that I will be able to solve it on my own no matter how hard I try.					
9. When I have a problem, I believe that it can be solved.	0	1	2	3	4
10. I go out of my way to avoid having to deal with problems in my life.	0	1	2	3	4
11. Difficult problems make me a very upset.	0	1	2	3	4
12. When I have a decision to make, I try to predict the positive and negative consequences of each option.	0	1	2	3	4
13. When problems occur in my life, I like to deal with them as soon as possible.	0	1	2	3	4
14. When I am trying to	0	1	2	3	4

solve a problem, I go with the first good idea that comes to mind.					
15. When I am faced with a difficult problem, I believe that I will be able to solve it on my own if I try hard enough.	0	1	2	3	4
16. When I have a problem to solve, one of the first things I do is get as many facts about the problem as possible.	0	1	2	3	4
17. When a problem occurs in my life, I put off trying to solve it for as long as possible.	0	1	2	3	4
18. I spend more time avoiding my problems than solving them.	0	1	2	3	4
19. Before I try to solve a problem, I	0	1	2	3	4

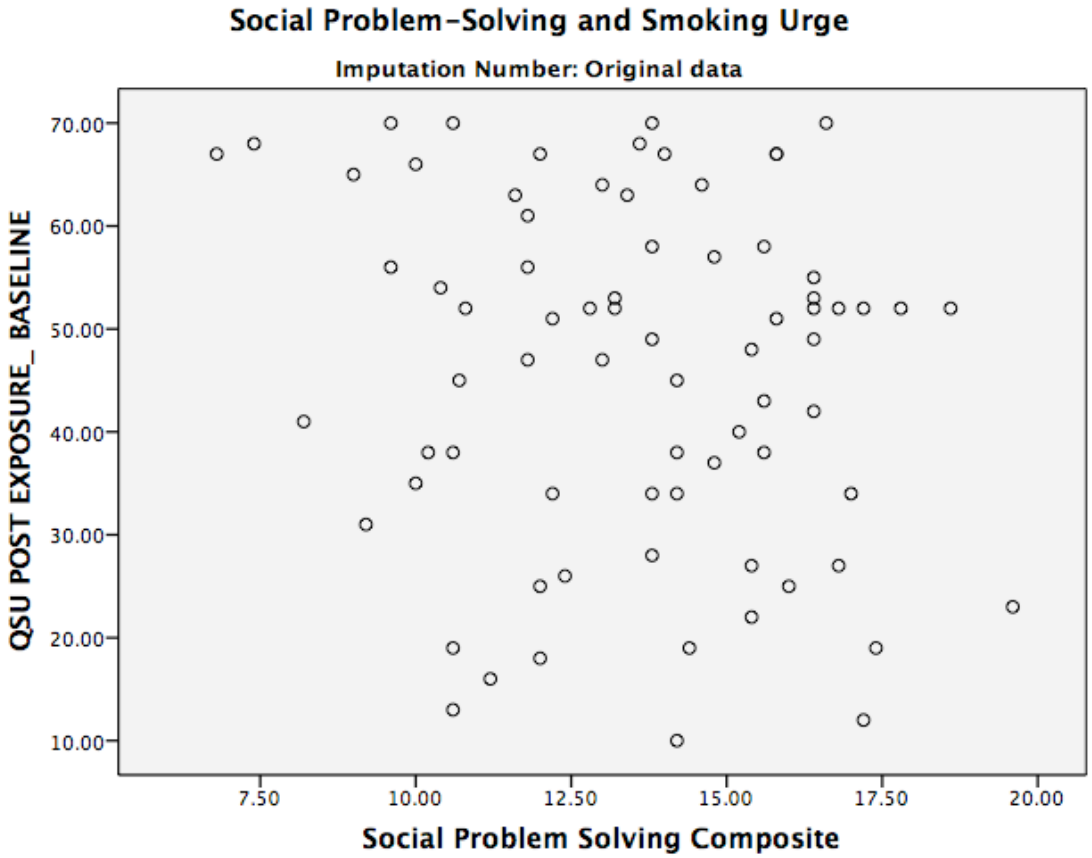
set a specific goal so that I know exactly what I want to accomplish.					
20. When I have a decision to make, I do not take the time to consider the pros and cons of each option.	0	1	2	3	4
21. After carrying out a solution to a problem, I try to evaluate as carefully as possible how much the situation has changed for the better.	0	1	2	3	4
22. I put off solving problems until it is too late to do anything about them.	0	1	2	3	4
23. When I am trying to solve a problem, I think of as many options as possible until I cannot come up with	0	1	2	3	4

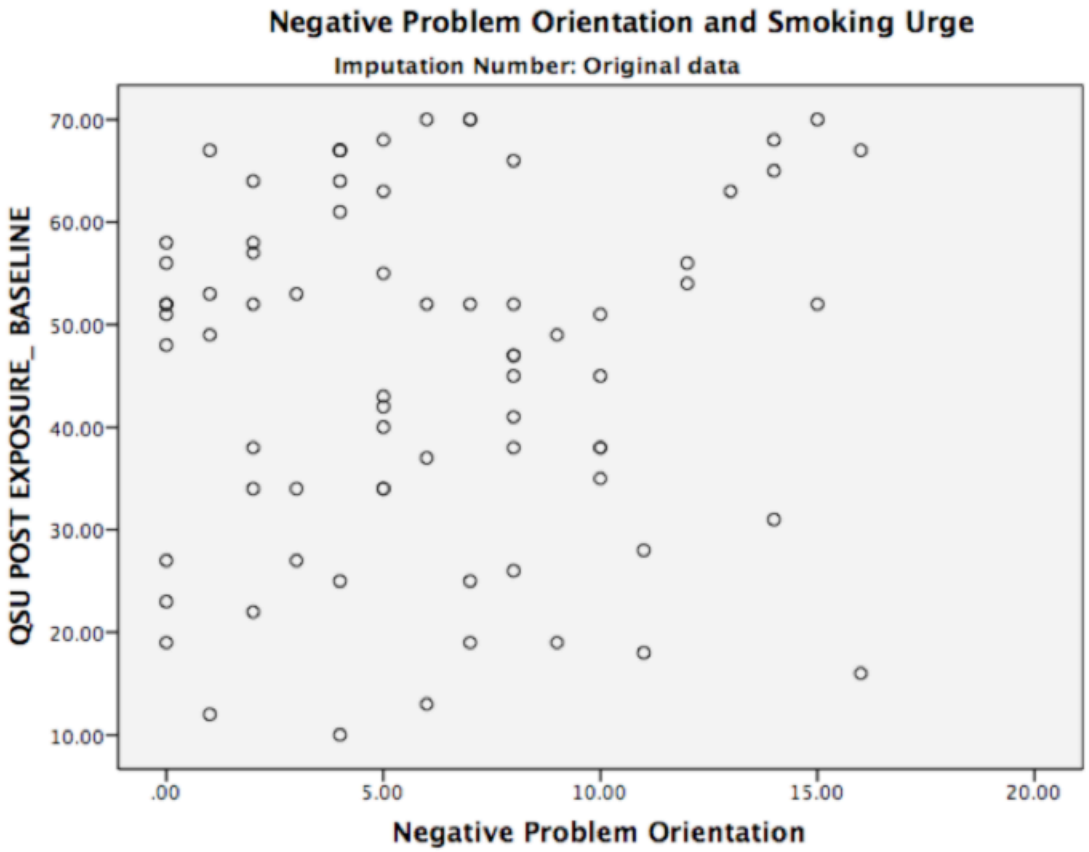
any more ideas.					
24. When making decisions, I got with my "gut feeling" without thinking too much about the consequences of each option.	0	1	2	3	4
25. I am too impulsive when it comes to making decisions.	0	1	2	3	4

Note: the SPSI-R:S is a licensed measure that should not be duplicated or used without the appropriate purchased copies.

APPENDIX F

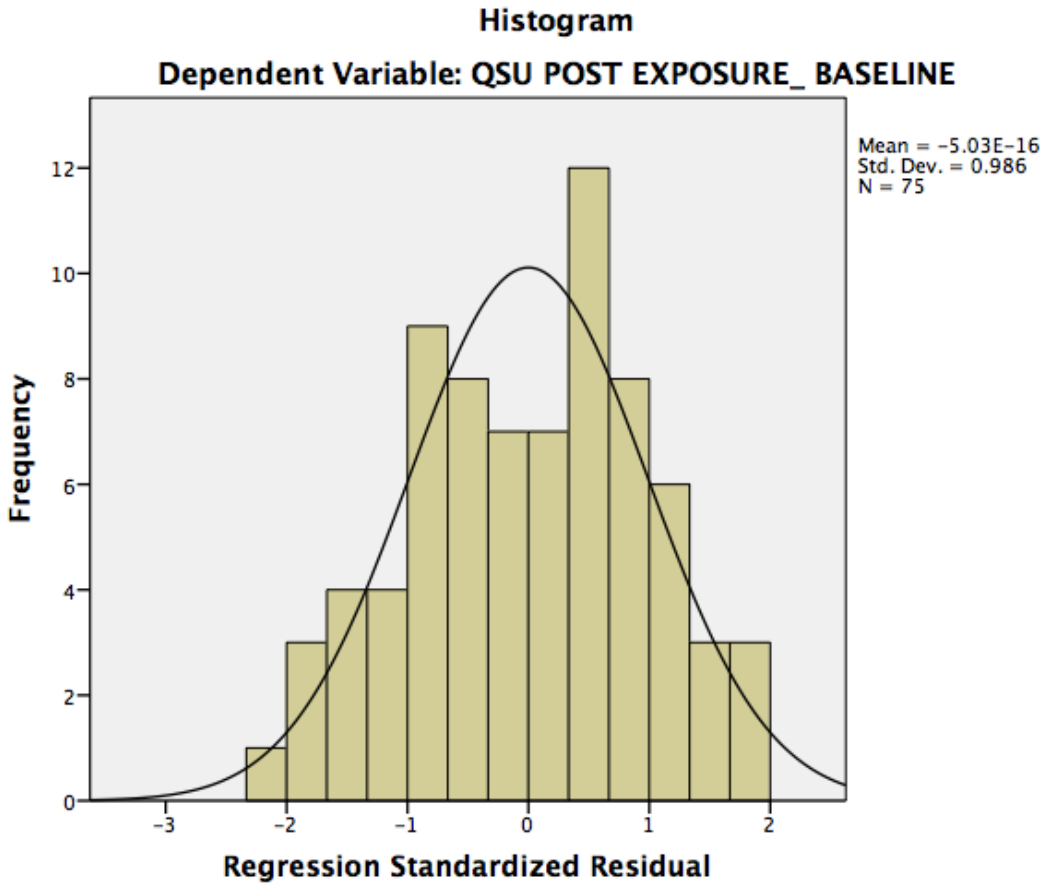
SCATTER PLOTS AIM 1 HYPOTHESES 1 AND 2

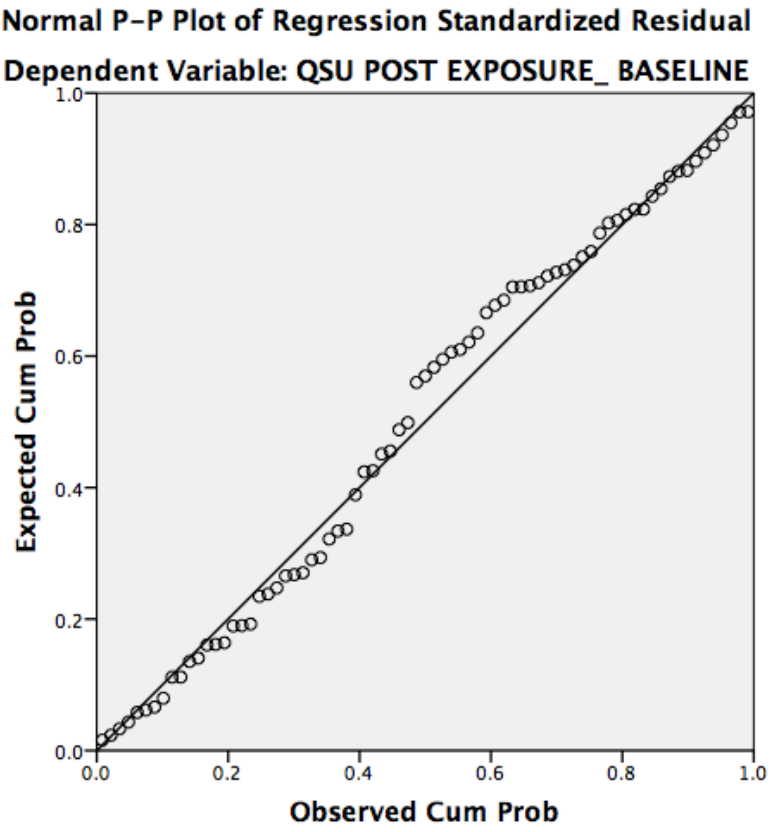



Negative Problem Orientation and Smoking Urge
Imputation Number: Original data
QSU POST EXPOSURE_ BASELINE
70.00
60.00
50.00
40.00
30.00
20.00
10.00
.00
5.00
10.00
15.00
20.00
Negative Problem Orientation

APPENDIX G

RESIDUALS FROM A REGRESSION WITH SOCIAL PROBLEM-SOLVING COMPOSITE SCORES AND CIGARETTES PER DAY PREDICTING POST-CUE EXPOSURE SMOKING URGE STRENGTH




Normal P-P Plot of Regression Standardized Residual
Dependent Variable: QSU POST EXPOSURE_ BASELINE
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0

APPENDIX H

NORMALITY TESTING

Variables being tested for normality:

- Fagerstrom Test of Nicotine Dependence (FTND)
- Social problem-solving composite (SPS composite)
- Negative problem orientation subscale (NPO)
- Impulsive-careless problem-solving style subscale (ICS)
- Smoking urges on the QSU-Brief post-exposure
- Negative affect post minus pre-exposure score
- Cigarettes per day

Numeric Tests for Normality

Shapiro-Wilks

Shapiro-Wilks (SW) tests, if produce significant p-values, indicate a divergence from a normal distribution. However, numerical tests may be the most stringent tests, and in the case of non-normal distributions as assess by SW, further visual tests will be conducted, or non-parametric tests will be used. The SW p-values are as follows:

- FTND: $p = .001$
- SPS composite: $p = .22$
- NPO: $p = .006$
- ICS: $p = .008$

- QSU change scores: p = .048
- Negative affect post minus pre changes: p = .001
- Cigarettes per day: p = .001

SW tests on all continuous variables used in this study provided statistically significant SW test values; all were $p < .05$ indicating non-normal distributions. With one exception; SPS composites were found to be normally distributed based on SW p-values (90), p = .22 and a Kolmorgorov-Smirnov test (p = .06). Conclusion: According SW tests, all data exhibit some degree of non-normal distribution, except SPS composites. Skew, kurtosis, and visual assessment of the distributions were also conducted.

Skew and Kurtosis

Skew and kurtosis scores provided through SPSS "Frequencies". Skewness values between -1 and 1 indicate little skew or kurtosis (Field, 2005). However, other sources suggest that skew and kurtosis values of -2 to 2 are acceptable (George & Mallery, 2010). The further these values are from 0 the more the data deviate from normality. The skew and kurtosis values for each variable are as follows (Skew, Kurtosis):

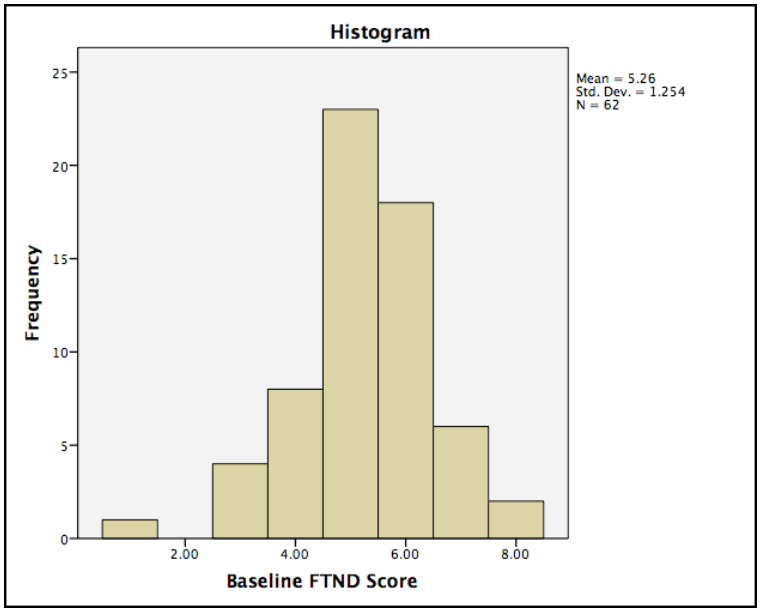
- FTND: (-.51, 1.4)
- SPS composite: (-.33, -.63)
- NPO: (.53, -.56)
- ICS: (.59, -.23)

- QSU-Brief: (.71, .64)
- Negative affect post minus pre changes: (.42, 1.98)
- Cigarettes per day: (1.1, 2.00)

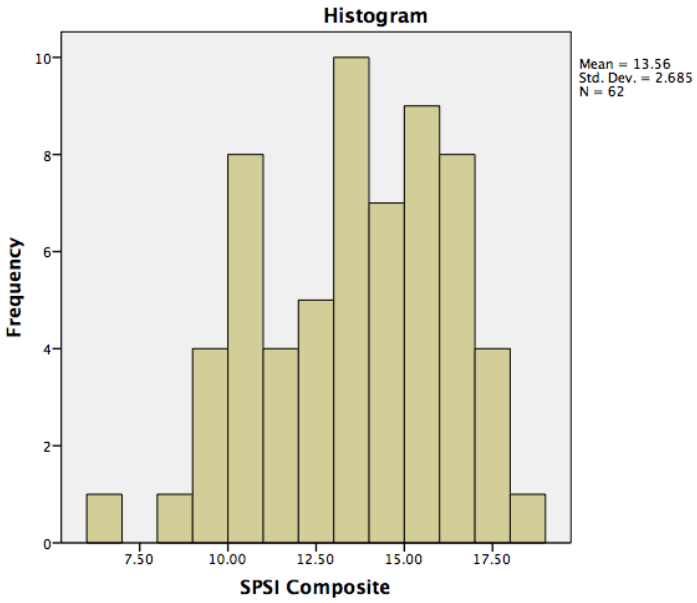
I. Visual Tests for Normality

a. Histograms

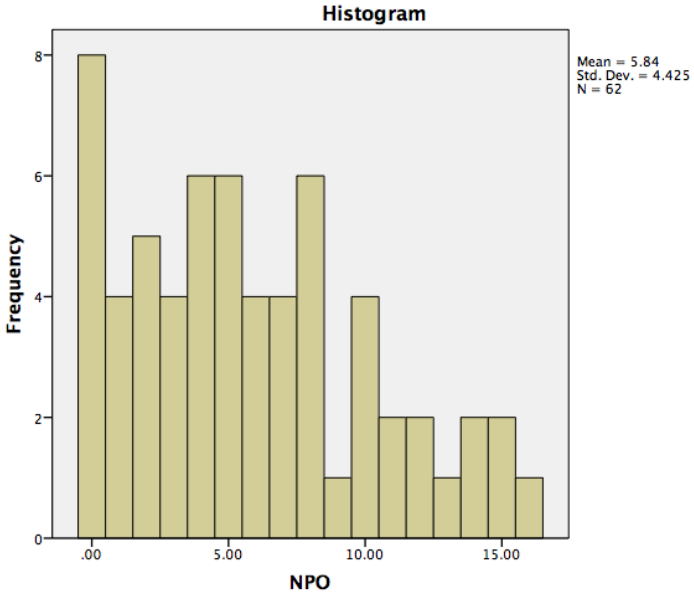
- FTND histogram



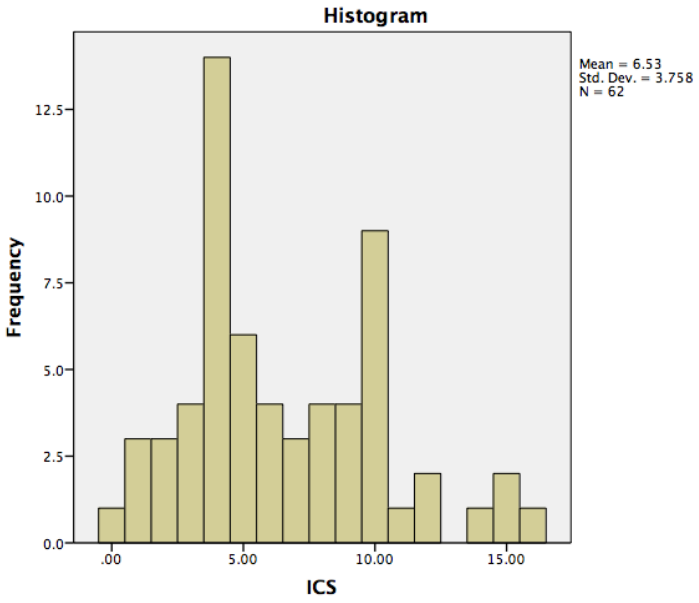
- SPS composite histogram



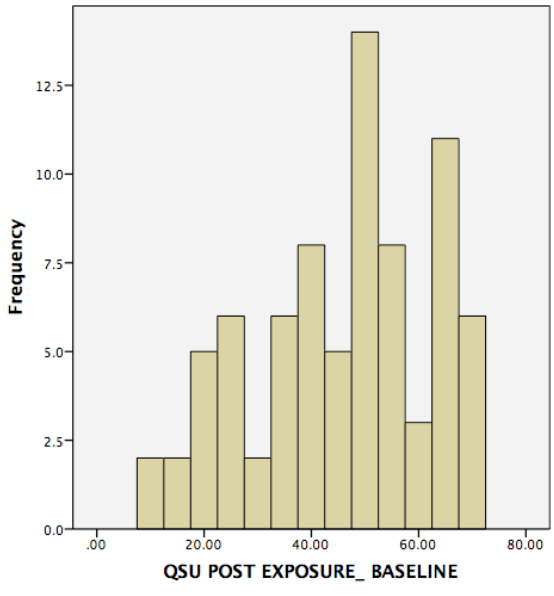
- NPO histogram



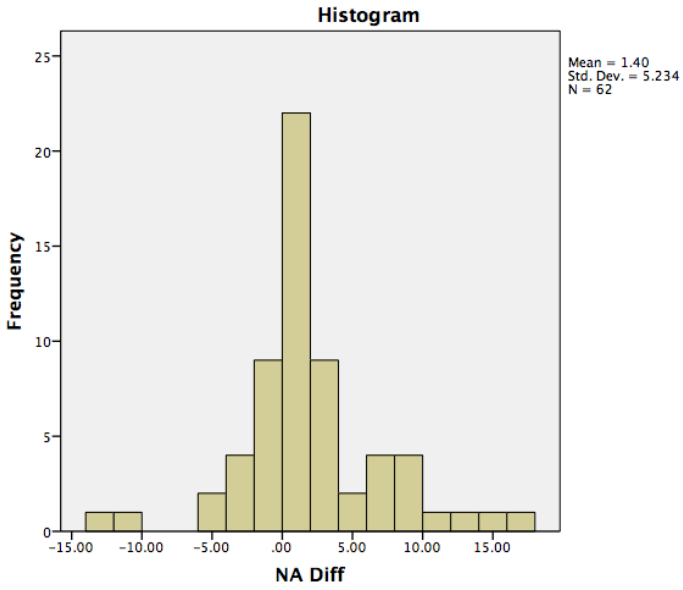
- ICS histogram



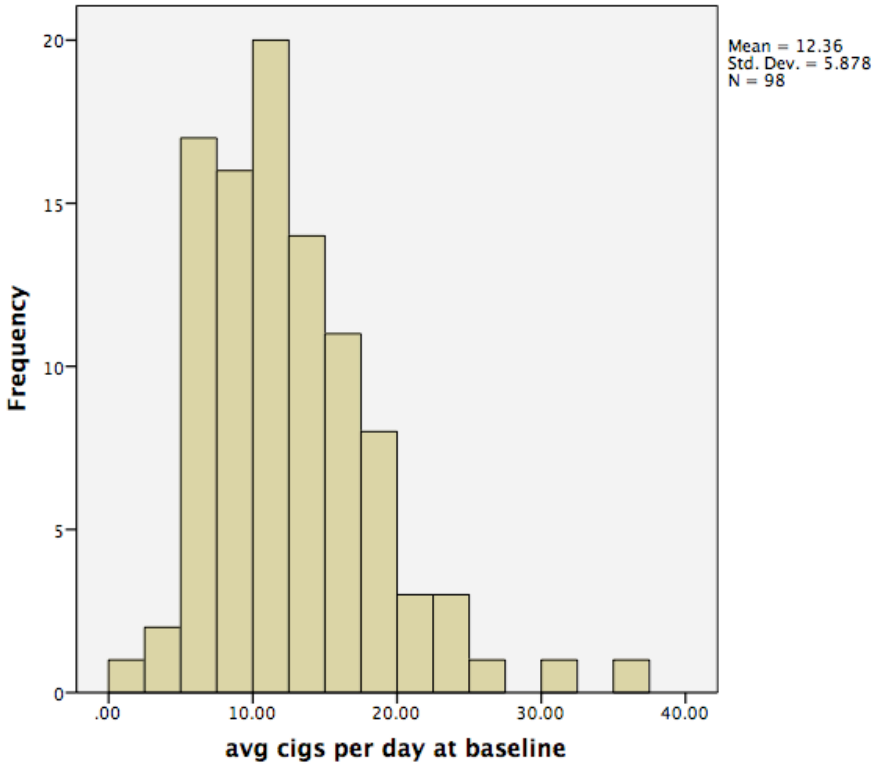
- QSU-Brief post cue exposure scores



- NA change scores histogram

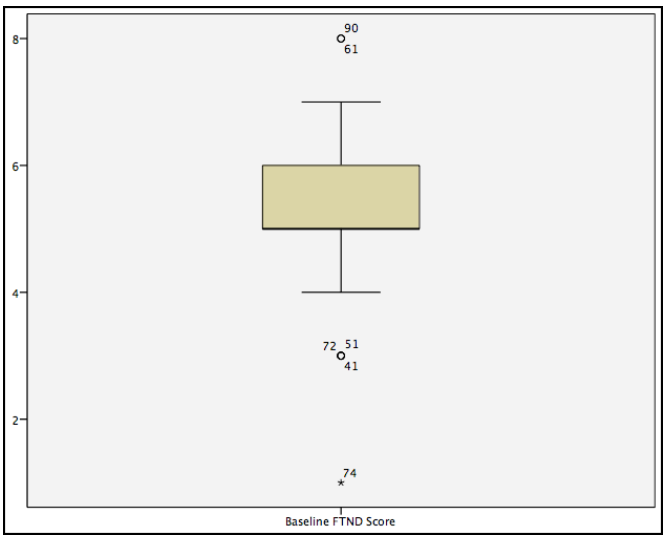


- Average cigarettes per day histogram

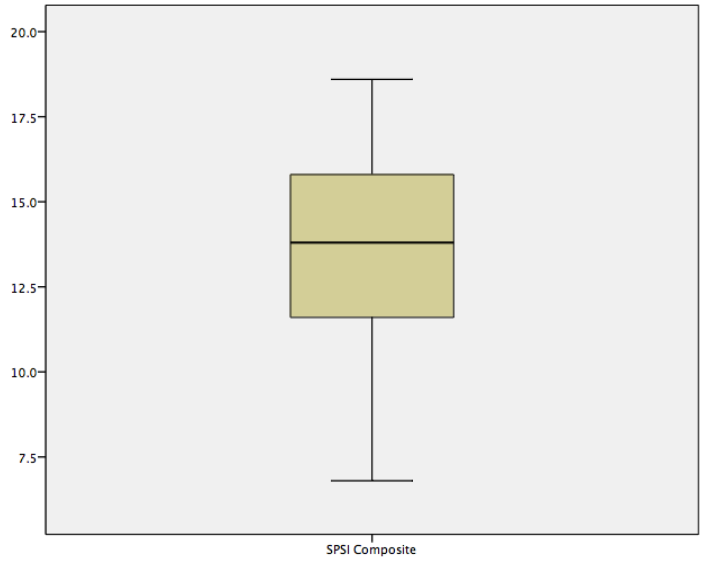


b. Box Plots

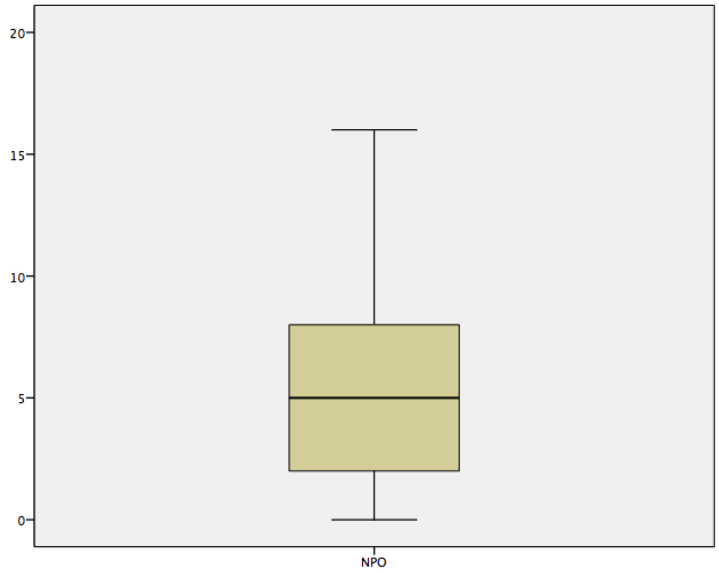
- FTND box plot



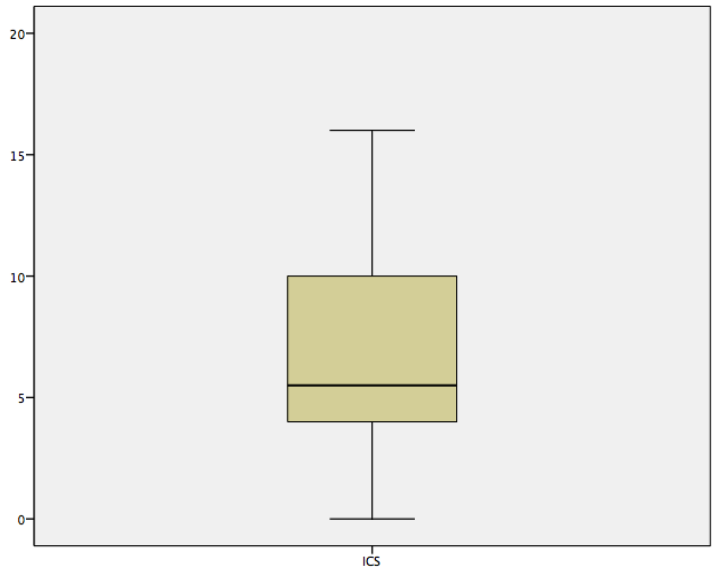
- SPS composite box plot



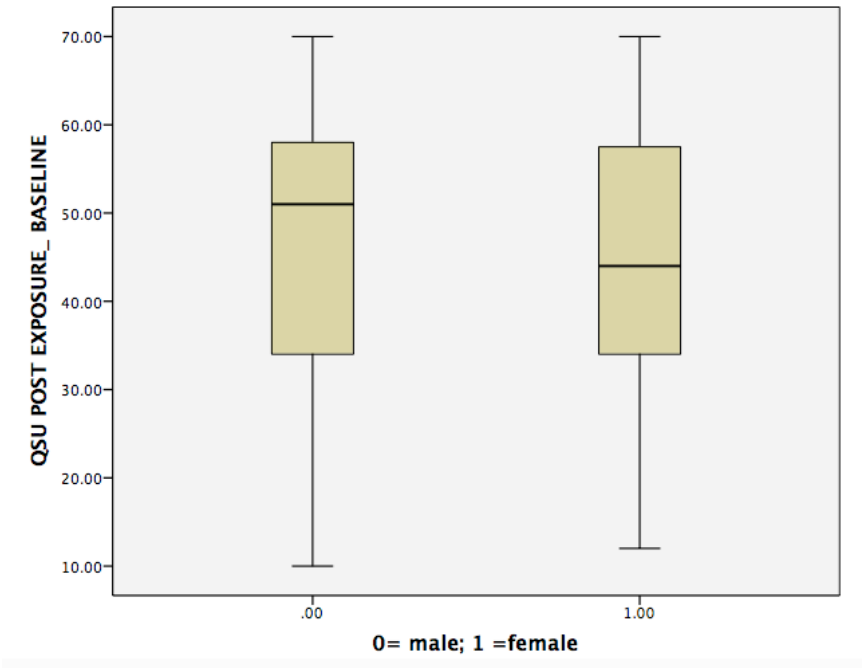
- NPO box plot



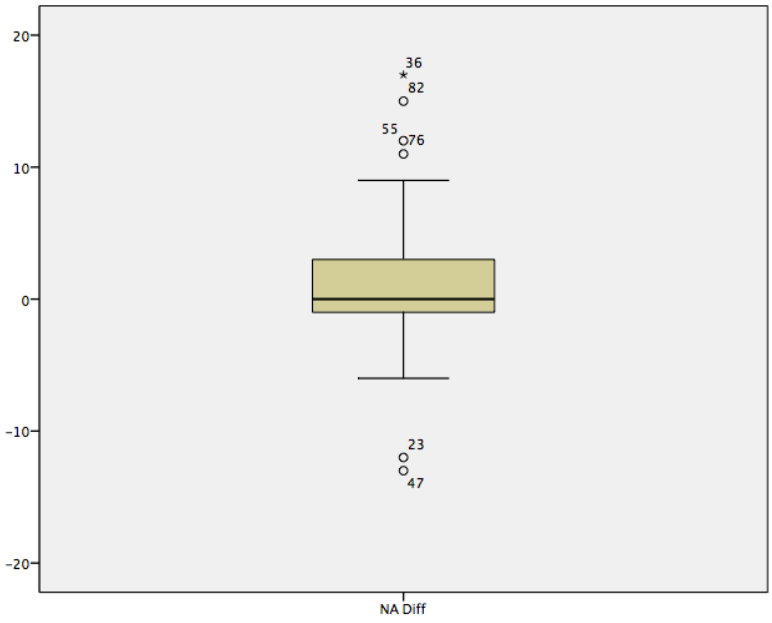
- ICS box plot



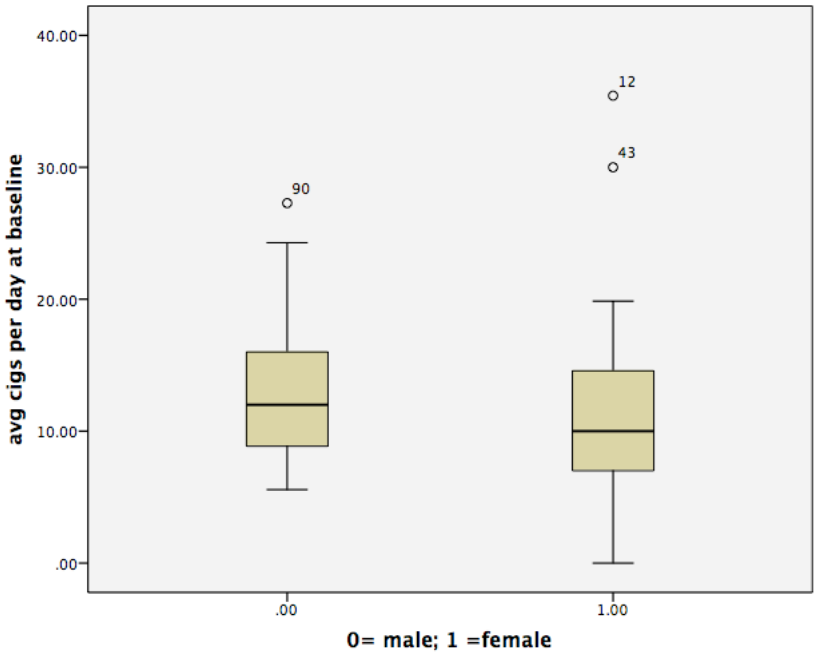
- QSU-Brief post-exposure scores



- Negative affect post minus pre cue exposure scores box plot



- Cigarettes per day by gender box plot



APPENDIX I

DEFINITION OF TERMS

Affect: A broad term used here to describe any pleasant or unpleasant emotional or mood states "interested, excited, strong, enthusiastic, proud, alert, inspired, determined, attentive, and active". Negative affective states assessed by the PANAS include: "Distressed, Upset, Guilty, Scared, Hostile, Irritable, Ashamed, Nervous, Jittery, Afraid".

Baseline Urge: The initial measurement of the strength of a person's psychological want or need to smoke. Baseline urge was measured among heavy smokers that were bio-verified abstinent for at least 2-3 hours. After receiving verbal instructions from a research assistant about the exposure session, then 5 minutes with soft piano music to provide some time for the person to become acclimated to the room, we measured Baseline Urge on the QSU-Brief and 10-item measure of multiple aspects of urges, and a single-item scale from Ussher's research that addresses strength of urge in the present moment on a scale of 0-5.

Conditioning: In this study, conditioning refers to the process by which animal or human behavior is guided by previous experiences. The outcome of experiences can be reinforcing, or punishing thereby creating motivations that guide behavior.

Cue: A cue, also known as a "conditioned stimulus" refers to any stimuli, external or internal, that has been previously associated with a rewarding or meaningful behavior (e.g. drug-related reward). Though drug use, users establish cues, later trigger ongoing use and relapse.

Cue Exposure: In this study the cue exposure refers to a brief relaxation period followed by a 5 minute task in which the participant experiences high salience imaginal and in-vivo tobacco and smoke-related stimuli using their preferred brand of cigarettes, lighting the cigarette, then seeing and smelling the smoke, but never smoking. Measures targeting negative affective states, as well as self-report questionnaires about strength of urges are taken before and after the exposure.

Cue Reactivity: Cue reactivity, also known as "conditioned response", is the collection of physiologic and psychological reactions (e.g. changes in blood pressure, changes in urge to smoke) that occur following exposure to drug-related cues. This study focused on self-reported increases in urge to smoke following exposure to smoking-related stimuli.

Dependence: "Dependence" is a multifaceted psychological and physiological syndrome characterized by continual, and habitual drug use, development of tolerance, compulsions, and urges to use nicotine, and experiences of withdrawal following onset of abstinence. Dependence often continues and drug use is made a priority despite negative social, economic, and health consequences.

Extinction: Extinction is the process by which the associations between conditioned stimulus and conditioned response are weakened. Extinction can be systematically promoted through cue exposure treatments, and through naturally occurring experiences that de-associated stimulus and response (e.g. encountering smoking cues without smoking).

Lapse: A lapse is any single use, or single episode of use, following a period of abstinence. Lapses may or may not become full relapses.

Positive Reinforcement: Positive reinforcement refers to pleasant or rewarding consequence's that follow certain behaviors (e.g. drinking, eating, sex, drug use). Behaviors that are reinforced are more likely to occur in the future.
Negative Reinforcement: Negative reinforcement refers to the removal of unpleasant or aversive experiences. For example, smoking can remove unpleasant withdrawal symptoms.

Relapse: The term "relapse" is sometimes used to describe any interruption of abstinence. However, today, relapse is more commonly defined as a process by which someone returns to previous levels of drug-use. In this study, the later, process-based, definition was used.

Social Problem-Solving: Social Problem-Solving (SPS) describes how people alter: a) the nature of the situation such that it no longer represents a problem, b) their maladaptive reactions to such problems or, c) both the situation and the maladaptive coping response to the problem. These processes include an individual's tendency to react with a positive problem orientation (views stressors as challenges with possible benefits, and withstand frustration) versus negative problem orientation (views stressors as emotionally overwhelming and as threats to well-being, and fails to effectively manage frustration) as well as engage in planned rational and adaptive, or maladaptive problem-solving strategies such as avoidance, or impulsive decision-making.

Urge: "Urge" and "craving" are sometimes used interchangeably. This study uses "urge" to refer to self-reported psychological desires, and "cravings" to refer to the physiologic drug wanting (e.g. feeling restless).

Urge Reactivity: Urge reactivity is the subjective, mental state of craving caused by exposure to conditioned cues. In other words, urge reactivity is the psychological component of cue reactivity. In this study, urge reactivity is defined by post-exposure strength of urge.

Withdrawal: Withdrawal is a syndrome of physiological and psychological effects that drug-dependent users may feel during periods of drug deprivation.