IMPULSIVITY AND SELF-EFFICACY IN SMOKING CESSATION

by

ERIN JONES

(Under the Direction of Lawrence Sweet)

ABSTRACT

Smoking tobacco is a major threat to public health, but only a small percentage of smokers succeed in quitting. Given this, extant literature has begun to examine modifiable internal factors, such as impulsivity and self-efficacy, as intervention targets for improving cessation outcomes. The present study examined interrelationships between trait impulsivity, impulsive behavior, and self-efficacy, and the degree to which they predict smoking cessation outcomes in a sample of adult cigarette smokers motivated to quit. Three hypotheses were examined: first, it was expected that behavioral impulsivity would exacerbate the expected negative effects of trait impulsivity on self-efficacy. Second, it was hypothesized that multiple measures of impulsive behavior would exhibit good convergent validity and when combined would serve as a better predictor of cessation outcomes than either measure alone. Finally, it was expected that trait impulsivity's expected negative effect on smoking cessation would be attenuated by self-efficacy and exacerbated by impulsive behavior.

INDEX WORDS: Smoking, Smoking cessation, Impulsivity, Trait impulsivity, Impulsive behavior, Delay discounting, Positive urgency, Negative urgency, self-efficacy

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CHAPTER 1

INTRODUCTION

Smoking tobacco has been the number one cause of preventable death in the United States for nearly fifty years and it continues to cost the country nearly half a million lives and $300 billion annually (Centers for Disease Control [CDC], Economic Trends in Tobacco, 2020; McCarthy, 2014; Substance Abuse and Mental Health Services Administration [SAMHSA], 2018). Smoking causes numerous diseases, including cancer, heart disease, stroke, and diabetes, and it is indirectly associated with countless other chronic health conditions, including cataracts, rheumatoid arthritis, and problems with fertility, pregnancy, and delivery (CDC, Health Effects of Cigarette Smoking, 2020). In addition to physical health risks, compulsive tobacco-seeking and use are core features of tobacco use disorder (TUD), which is a substance use disorder (SUD) that results in a wide array of impairing social, cognitive, physiological, and behavioral consequences (American Psychiatric Association, 2013).

Despite growing evidence of the connections between smoking and long-term detrimental outcomes, there are nearly 50 million current daily cigarette smokers aged 12 or older in the U.S. (SAMHSA, 2018). The majority of them want to quit but cannot. Although two out of three smokers report wishing to quit, less than 8% of attempts are successful, and relapse rates following smoking cessation treatment typically exceed 50% (Centers for Disease Control, Smoking Cessation: Fast Facts, 2020; García-Rodríguez et al., 2013; U.S. Department of Health and Human Services, 2020).

Consistent with addiction research overall, smoking cessation treatments are often unavailable, underutilized, and characterized by poor retention and high relapse rates (Babb et al. 2017; Blumenthal 2007; Fiore et al. 2008). It is estimated that even when receiving the "gold standard" of treatment, a combination of behavioral therapy, nicotine replacement therapy (NRT), and medical management of withdrawal symptoms, short-term smoking relapse rates still exceed 50% within the first year, and actual long-term abstinence after twelve months hovers close to only 15 to 20% (Fiore et al. 2008; García-Rodríguez et al. 2013). Given that the current gold standard of treatment is still missing the mark for effective long-term reduction of smoking and the risks associated with it, more research is needed to understand which factors best predict long-term cessation, so they may be implemented more effectively in both individual and large-scale public health intervention (CDC, Smoking Cessation: A report of the Surgeon General, 2020).

In an attempt to boost the efficacy of smoking cessation treatments, researchers have been investigating individual factors that promote abstinence. Among them, years of education, income, marital status, and length of treatment all have positive effects on long-term success, whereas stress, exposure to other smokers, and lack of social support predict relapse (Lee and Kahende, 2007; Polizzi et al., 2004). For instance, studies have found that higher educational attainment and income are associated with a greater likelihood of reattempting to quit after a relapse, but, paradoxically, a history of quit attempts, in and of itself, is associated with subsequent relapse (Borland et al., 1991; Wilcox et al., 1985). Sex also appears to moderate the effects of individual characteristics, such as living environment or age (Derby et al., 1994; Hymowitz et al., 1997). However, it is implausible to intervene upon static factors such as age and sex. Further, mitigating the effects of education and income levels with techniques such as

monetary rewards for quitting are limited by both the availability of funding, as well as limited research on the differences in efficacy of monetary rewards between intrinsically versus extrinsically motivated smokers (van den Brand et al., 2020). Therefore, additional cost-effective, plastic, and potent targets of intervention are needed.

One promising domain that has not been fully explored in smoking cessation research is modifiable internal factors. A myriad of modifiable internal factors, such as stress, negative affect, depression, anxiety sensitivity, inadequate coping skills, self-efficacy, and impulsivity have been examined as risk factors with some success (Balevich et al., 2013; Carmody et al., 200; Langdon et al., 2015; Perkins et al., 2012; Rausch et al., 1990; Shiffman and Waters, 2004). For instance, low motivation and confidence, as well as heightened vigilance and attention to negative mood and physiological states appear to play a key role in smoking maintenance (Rae, 2014). Specifically, over-attending to negative mood, physical sensations, and feared outcomes, such as relapse, are all associated with continued smoking (Carmody et al., 2007). In clinical applications, individual factors can be a useful targets of cessation intervention, and acceptance-based interventions that emphasize emotion regulation and reappraisal of craving and negative mood appear to moderate the effects of mood on smoking behaviors (Davis et al. 2007; Gifford et al. 2004; Marlatt et al. 2004). Further, exposures to smoking cues and withdrawal help desensitize smokers to the salience of learned triggers (Barlow, Allen and Choate 2004).

Though research on individual factors in smoking cessation shows promise for informing treatment and predicting outcomes, results have been limited by a narrow range of predictors studied and a lack of integration of findings. Moreover, few studies examining smoking cessation compare at the same time the relationship between subjective, self-reported traits and objectively observed behaviors as separate constructs with different predictive utility (Lee and

Kahende, 2007). An emerging body of research on smokers with anxiety suggests that examining both traits and behavior as separate variables offers better accuracy in predicting how individuals will respond behaviorally to various situations, and in turn experience different smoking outcomes (Watson et al., 2018). In fact, there is evidence to suggest that the utility of self-reported traits in predicting behavior can be limited by individuals' levels of insight and accurate reflection of traits (Gosling et al., 1998). However, little research has examined traits, behaviors, and their interacting relationships among other individual factors associated with smoking, and those that do frequently rely on subjective and often imprecise measures that depend on retrospective rating of trends in behavior over time (Gilpin and Pierce, 1994). Given these limitations, a more balanced, updated view of smoking cessation is needed. Thus, a multivariate approach, which includes concurrent examination of both individual traits and behavioral observation of impulsivity, is a promising approach to advance our current understanding of smoking behavior and subsequent outcomes over time.

Impulsivity, Reward and Decision-Making

In response to sub-optimal outcomes of smoking cessation treatment, a growing body of research has been examining modifiable individual characteristics that are most strongly associated with smoking behavior and cessation outcomes. One modifiable trait that is often examined in TUD and other SUDs is impulsivity. Impulsivity has been defined as a preference for short-term, readily available rewards and a relative difficulty regulating responses to a reward (Doran et al., 2004). Although impulsivity can broadly be characterized by immediate or unplanned behavior lacking inhibitory control, impulsivity is more nuanced when examined

under cognitive, behavioral, social, biological, or other lenses, such as addiction (Bakhshani, 2014).

According widely accepted models of impulsivity, it can be divided into trait impulsivity that remains relatively stable over the lifespan and impulsive behavior that varies situationally in response to different environmental cues (Doran et al., 2004; Potvin et al., 2015 Wingrove and Bond, 1997). Although there is a well-demonstrated link between trait impulsivity and impulsive and addictive behavior, quantifying trait impulsivity and impulsive behavior can be an elusive task, as many assessments of impulsive behavior do not directly correlate as expected with self-reported impulsive traits (Murphy and MacKillop, 2012; Wingrove and Bond, 1997). Not surprisingly, heterogenous definitions and segmented approaches to studying impulsivity have resulted in widely varying perspectives on how best to measure it and its utility in SUDs interventions.

Trait impulsivity has traditionally been measured through retrospective self-report personality questionnaires such as the Barratt Impulsiveness Scale (BIS), the Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency (UPPS-P) impulsive behavior scale, and the Eysenck Impulsiveness Scale (EIS) (Barratt, 1959; Cyders et al, 2007; Eysenck et al., 1985; Whiteside and Lynam, 2001). Such measures assess trait impulsivity through series of questions about different domains. For example, the UPPS-P measures impulsivity across the dimensions of the Five Factor Model of Personality, including traits such as positive and negative urgency, lack of planning or perseverance, and sensation-seeking (Whiteside and Lynam, 2001; Cyders et al, 2007). Though regarded as a stable measure over time, interventions targeting trait impulsivity and its components have shown promising results in terms of reducing impulsive or addictive behaviors, highlighting their usefulness in modification of traits that are

usually fairly unchanging otherwise. For example, mindfulness interventions have been associated with increased perseverance, as well as attenuation of impulsive responses to strong negative or positive affect (Murphy and MacKillop, 2011; Teper et al., 2013; Vinci et al., 2013). Brief relaxation exercises have also been used successfully to increase positive affect and reduce negative urgency to drink in a sample of at-risk, college-aged drinkers (Vinci et al., 2016). However, given such widespread support for impulsivity as a multidimensional construct related to addiction, further extension of impulsivity assessments and interventions is warranted to better understand the link between self-reported trait impulsivity and observed impulsive behavior in smoking.

Impulsive behavior can be difficult to measure as it varies situationally, or even momentarily, and is not consistently correlated with self-reports of trait impulsivity in laboratory settings (Reynolds et al., 2006; Sharma et al., 2013; Tomko et al., 2014; Wingrove and Bond, 1997). This more dynamic aspect of impulsivity is often neglected simply because the dominant measures of impulsivity, multi-factor personality assessments and retrospective self-reports, have targeted trait impulsivity through self-report questionnaires (Reynolds et al., 2006). More recently, several behavioral impulsivity assessment approaches have been used, including high frequency, real world sampling of self-reported behavior through ecological momentary assessment (EMA; Sharma et al., 2013; Tomko et al., 2014). However, the usefulness of EMA for measuring impulsive behavior is limited by variation in an individual's insight about what constitutes impulsive behavior, thus still representing subjective reports of trait impulsivity more than impulsive behavior (Reynolds et al., 2006; Sharma et al., 2013; Tomko et al., 2014; Wingrove and Bond, 1977). Further, subjective EMAs of impulsivity are still limited by participant compliance, social-desirability bias, and missing responses (Wray et al., 2014).

Another approach to assessing impulsive behavior is through direct observation during performance of a behavioral task. Examples of such tasks include the go/no-go task and Balloon Analogue Risk Task (BART; Gomez et al., 2007; Lejuez et al., 2002). The go/no-go task measures inhibitory control of a primed rapid motor response by requiring participants to repeatedly press a key on a computer when they see a "go" signal, and inhibit this primed key-pressing when a "stop" signal is presented (Gomez et al., 2007). During the BART, which measures risk-taking, participants are presented with a computer model of a balloon that may be 'inflated' with each key press, which rewards the participant but incrementally increases the likelihood that the balloon will 'pop' and the participant will lose all their rewards (Lejuez et al., 2002). Although both inhibitory control and risk-taking are associated with impulsive behavior, these constructs may be less relevant than the higher order decision-making about reward associated with maintenance of established, problematic substance use (Lejuez et al., 2003; Luitjen et al., 2011). Given this, measures of impulsive behavior that specifically target decisions about reward may have stronger potential to predict subsequent outcomes in established smokers. In turn, combining accurate measures of impulsive behavior and choices with well-supported measures of trait impulsivity may better predicting successful cessation than either assessment alone.

Behavioral Economics

One particularly useful and objective means of assessing and quantifying impulsive behavior is through behavioral economics (Bickel et al., 1991; Bickel et al., 1998; Thorgeirsson and Kawachi, 2013). Behavioral economics provides an elegant, quantitative explanation for why individuals choose to initiate and maintain behaviors such as cigarette smoking despite its

negative implications for long-term health (Barlow et al., 2016; Johnson and Bickel, 2003). From this perspective, decision-making is a mathematical function of the costs, constraints, and effort involved in obtaining a desired stimulus compared to the rewards, benefits, or advantages received upon acquiring it (Rachlin et al., 1981). This can be labeled as the “unit price,” or behavioral, economic, and social costs per unit of reinforcement; in most cases, individuals will seek to obtain the largest amount of reinforcer for the lowest available “price” (Bickel et al., 1991).

Historically, the basic premise of the unit price theory is well-supported, and it has been demonstrated that an increase in unit price for a desired stimulus tends to have a negative effect on consumption at a positively decelerating rate (Bickel et al., 1991). However, despite the theoretical strength of such economic principles, the practical applicability of these theories becomes much more complex outside the laboratory setting (Ainslie and Herrnstein, 1981). For instance, individuals’ in-vivo cost-benefit analyses and unit price limits are typically not linear, and instead may vary logarithmically over time (Acuff et al., 2020). Also, rather than existing as perfect logical beings that execute one-to-one ratios of cost-per-benefit exchange, humans are limited by “bounded rationality:” simply put, individuals possess limited cognitive processing ability and make decisions based on individualized heuristics unique to their situations (Kahneman et al., 1982; Mullainathan and Thaler, 2000). This results in unique decision-making curves that vary by life-situation, rather than simple one-to-one ratios of costs and benefits. In this way, impulsivity necessitates precise instruments for measuring decision-making that take into consideration variance in both individuals’ traits and the malleability with which they behave in different environments.

There are several ways that the cost-benefit analyses of behavioral economics may be assessed to provide valuable information about predicting impulsive behavior, one of which is a concept known as delay discounting (Madden and Bickel, 2010; Moreira and Barbosa, 2019; Odum, 2010). Delay discounting (DD) refers to the ratio of want for a reward to the delay required to receive it (Mazur, 1987; Odum, 2010). For instance, DD is useful in calculating a numerical value, known as a "k-value," for how much a reward is "discounted," or valued less, per increment of time it would take to receive it (Chung and Herrnstein, 1967; Lattal, 2010). Behavioral measures of DD, such as the Monetary Choice Questionnaire (MCQ) may be given repeatedly over time to quantify how DD changes in response to learning or intervention (Towe et al., 2015). Although some initial research indicates that k-values remain relatively stable when administered in similar or identical situations, discounting rates may fluctuate based on the situation, reward, and level of desire for the reward, supporting assessment of impulsive behavior as a construct unique from trait impulsivity due to its inherently more fluctuating nature (Kirby, 2009).

Impulsivity, Reward and Behavioral Economics of Smoking Behavior

Impulsivity and Reward in TUD and Psychiatry

Trait impulsivity and impulsive behavior both influence smoking decisions and outcomes (Balevich et al., 2013; Billieux et al., 2007; Harrison et al., 2009). In particular, negative and positive urgency tend to be most strongly associated with SUDs, as negative and positive affect appear to be associated with cravings and the desire to numb or amplify emotional experiences, respectively (Berg et al., 2015; Billieux et al., 2007; Bloom et al., 2014). It is believed that trait impulsivity, especially urgency, drives subsequent impulsive behavior and substance use (Berg

et al., 2015; Sharma et al., 2013). Thus, although urgency and substance use behaviors are positively correlated, studies comparing impulsive traits with behavioral manifestations like substance use are modest (Berg et al., 2015; Sharma et al., 2013). One possible reason for this could be that individual awareness of impulsive tendencies results in compensatory reductions in impulsive behavior, thus attenuating the effects of trait impulsivity, but that such attenuations are small and may not be sufficient for mitigating the effects of trait impulsivity in high temptation situations like substance use (Wingrove and Bond, 1997).

It is well-documented that psychiatric conditions associated with impulsivity are also associated with increased likelihood of smoking (Moeller et al., 2001). For instance, attention-deficit/hyperactivity disorder (ADHD), which is characterized by patterns of impulsivity, is associated with a 40% higher risk of cigarette smoking compared to the general population (Downey et al., 1996; Grant et al., 2004; Lasser et al., 2000). Impulsivity is also commonly observed in serious mental illnesses such as bipolar disorder, borderline personality disorder, and schizophrenia, which are also associated with elevated smoking rates (Enticott et al., 2008; Heery et al., 2007; Hoptman, 2015). It is possible that impulsivity may also be a contributing factor to smoking prevalence in schizophrenia that is nearly 90% (NIH State-of-the-Science Panel, 2006). Further, research has found that even subclinical levels of trait-level impulsive symptomatology and subsequent impulsive behaviors are associated with increased risk for smoking (Kollins et al., 2005). Given that trait-level impulsivity and impulsive behavior are each risk factors for not only smoking, but several psychiatric conditions, accurate measurement of impulsivity is critical in testing models of SUDs interventions and for identifying those at highest risk of suffering negative health outcomes.

Behavioral Economics of Smoking

Behavioral economics is well-supported as a sound approach to the study of impulsivity during decision-making in SUDs that may help to explain why individuals seem to overlook the numerous negative health consequences of smoking (Barlow et al., 2016; Johnson and Bickel, 2003). Through behavioral economics, smoking can be understood as a cost-benefit analysis of the investment, obstacles, and total effort required to receive cigarettes compared to the various rewards or relief of acquiring and using them (Rachlin et al., 1981). Smokers develop a “unit price” per cigarette based on this cost-benefit analysis, and consumption tends to decrease as unit price increases (Bickel et al., 1991). However, real-world smoking behaviors are complex and require precise measurement of both trait-level impulsivity and impulsive behavior in decision-making about rewards (Ainslie and Herrnstein, 1981).

Both in addiction literature at large and specifically in smoking and TUD, higher rates of regular substance use are associated with greater discounting of long-term rewards and outcomes: short-term rewards, even if they are less ‘valuable’ than long-term rewards, are often preferred (Athemneh et al., 2017; Gray et al., 2017; MacKillop et al., 2012). It is believed that over time, increased substance use serves to further distance individuals from the likelihood of engaging in alternative activities, which further reinforces the short-term reward of using over the potential long-term benefits of abstinence (Barlow et al., 2017). Theories in behavioral economics suggest that the reason why delays may result in such significant discounting, even to the point of individual harm or death, is because both the value associated with an immediate reward and the imagined effort or suffering associated with a delayed reward tend to be overestimated (Odum, 2011). However, even with behavioral economics in mind, much is still

unknown about the mechanisms of onset, maintenance, and cessation in TUD and how much awareness and control individuals have over each once patterns of substance use are established.

Control and Beliefs about the Self

Consistent with addiction research overall, increasing findings in smoking and TUD research highlight the importance of perceived and actual control in onset, maintenance, and recovery outcomes in SUDs (Lassi et al., 2019). Locus of control (LoC) is a malleable trait that encompasses how strongly individuals believe they are responsible for, and able to control, thoughts, feelings, behaviors, and situations (Rotter, 1966). LoC is often described on a spectrum: individuals with a stronger external LoC tend to believe that events are the result of chance or forces outside of their control, whereas those with stronger internal LoC tend to believe events are a direct consequence of their behaviors (Carlson, 2007).

In alcoholism, higher external LoC has been associated with worse treatment compliance and more failed attempts to quit drinking, whereas higher internal LoC tends to promote higher rates of treatment completion and longer periods of abstinence (Caster and Parsons, 2015; Murray et al., 2008). Similar findings have been reported in smoking: a substantial body of literature suggests that higher internal LoC predicts long-term abstinence (Rosenbaum and Argon, 1979; Stuart et al., 1994). Further, Lassi et al. (2019) found that individuals with higher external LoC exhibited increased tobacco consumption compared to those with higher internal LoC. Interestingly, it has been demonstrated that individuals exhibit the highest levels of internal LoC prior to initiating any smoking behaviors, and experience an increase in external LoC as smoking behaviors become more regular (Clarke et al., 1982; Eiser et al., 1989; Srivastava, 2015). Given that individuals appear to have the highest levels of internal LoC prior to beginning

to smoke, and higher external LoC is associated with poorer long-term outcomes, more research is needed to elucidate how LoC may mitigate or amplify long-term risk trajectories in smoking.

Self-efficacy and Smoking Behavior

Closely related to LoC is a more nuanced construct: self-efficacy. Self-efficacy was identified by Bandura (1977) as individuals' beliefs about their abilities within specific domains or skillsets to control and cope with what happens to them. Where LoC represents broadly how much an individual tends to believe in their general position of responsibility for events, self-efficacy captures exactly how much an individual feels confident that they can practically and realistically manage a particular situation or challenge (Bandura, 1977; Roddenberry and Renk, 2010). For example, a person with high internal LoC about smoking may believe that they are directly responsible for their decisions about smoking or abstinence, but they may exhibit low self-efficacy and feel unable to engage in behaviors necessary to quit.

Several studies have posited that, similar to LoC, self-efficacy is a dynamic trait that may change in response to one's own smoking status and behaviors (Baer et al., 1986; DiClemente et al., 1985; Perkins et al., 2012; Shiffman et al., 2000). Unique to self-efficacy, emerging research suggests fluctuations even on a day-to-day scale (Shiffman et al., 2000). Congruent with this, self-efficacy and abstinence-maintaining behaviors increase with successful smoking cessation, and decline following relapse, creating the potential for cyclical relationships of change or maintenance (Perkins et al., 2012). Because self-efficacy appears to be an even more plastic, situational factor than LoC, it is possible that it may serve as a valuable extension, and necessary specification, to previous research on LoC in smoking cessation. Further, research is needed to

understand how self-efficacy interact with other individual factors to predict subsequent substance use outcomes.

Associations between impulsivity and self-efficacy and their effects on smoking cessation

Given evidence of the importance of impulsivity, both as a trait and in observed behavior, and self-efficacy in smoking, it stands to reason that the interaction of these factors may predict unique variance in smoking cessation above and beyond the predictive utility of these individual factors alone. Initial research in marijuana use shows a mediating effect of self-efficacious behavior on impulsive decision-making characteristic of substance use initiation and maintenance (Hayaki et al., 2010). In alcohol use, drinking refusal self-efficacy is a mediator in the relationship between impulsiveness and hazardous drinking (Gullo et al., 2010). To date, no research has examined such a relationship in smoking, let alone using a multi-method approach that assesses both self-reported trait and objective behavioral impulsivity. By examining complex interactions of self-efficacy and dimensions of impulsivity, understanding of mechanisms of smoking cessation may be expanded.

Present Study, Aims, and Hypotheses

Given evidence of the importance of trait impulsivity, impulsive behaviors, and self-efficacy over the course of substance use initiation and maintenance, the present study will investigate interactions between these factors for effects on smoking cessation treatment outcomes. Specifically, it will first be examined whether impulsive behavior moderates the expected effect of trait impulsivity on self-efficacy in a sample of smokers presenting for smoking cessation. Second, a novel measure of DD will be assessed for convergent validity with

the MCQ in order to determine whether both assessments may be combined into a composite measure of impulsive behavior. Finally, it will be examined whether expected negative effects of trait impulsivity on 9-week smoking cessation outcomes attenuate the effects of self-efficacy and are exacerbated impulsive behavior. Given that self-efficacy and impulsive behavior are both highly variable and modifiable traits, it is possible that they could be effective targets for further development of cessation interventions.

Three hypotheses are examined. First, it is hypothesized that trait impulsivity, measured by the positive and negative urgency subscales on the Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency (UPPS-P) impulsivity scale, will have a direct negative effect on self-efficacy measured by the Smoking Self Efficacy Questionnaire (SEQ), but that this relationship will be moderated by levels of impulsive behavior, assessed using impulsivity scores generated from the Monetary Choice Questionnaire (MCQ). Specifically, higher behavioral impulsivity is expected to amplify the negative effects of trait impulsivity on self-efficacy. Second, it is expected that an extended DD task k-values will exhibit strong convergent validity with MCQ k-values, and thus, represent a more reliable measure of impulsive behavior when averaged together with the MCQ as a composite than either assessment alone. Third, it is hypothesized that trait impulsivity will have a direct, negative effect on 9-week smoking abstinence, such that those with higher trait impulsivity scores are more likely to resume smoking or drop out of treatment than those with lower trait impulsivity scores. It is expected that self-efficacy will moderate this relationship, such that higher self-efficacy attenuates the effects of impulsivity on smoking cessation, but that the impulsive behavior composite score will continue to moderate the effect of trait impulsivity on self-efficacy (i.e., the first hypothesis;

higher trait impulsivity will be associated with heightened behavioral impulsivity, which will in turn predict lower self-efficacy scores).

CHAPTER 2

METHOD

Participants

A total of 122 treatment-seeking cigarette smokers were recruited from the community via print and internet advertisements for a study of smoking cessation. Inclusion criteria for the treatment portion of the study were as follows: 1) age 18-65, 2) self-reported smoking of at least 10 cigarettes per day, and 3) self-reported 5 or greater on a 10-point motivation to quit scale. Exclusion criteria included: 1) weekly or higher frequency of illicit substances within the past 90 days, 2) history of major medical, psychiatric, or neurologic conditions, 3) any currently treated psychiatric disorders, and 4) any magnetic resonance imaging (MRI) contraindications, including but not limited to metal implants, pregnancy, or claustrophobia. All 122 participants completed a baseline assessment, which included the SEQ, UPPS-P, and MCQ needed to test Hypothesis 1. A subsample of 55 who were eligible for the treatment study completed a second assessment that included the DD functional MRI (fMRI) paradigm and initiated smoking cessation treatment needed to test Hypotheses 2 and 3.

Procedures

The study included a phone screen, a three-hour baseline eligibility intake assessment, an MRI assessment, a research assessment on quit day, a 9-week smoking cessation intervention, a 2-hour follow-up assessment one week after treatment completion, and two telephone follow-ups four and twelve weeks later (see Table 1). Following initial phone screening for study eligibility,

participants were invited for a 3-hour baseline eligibility intake assessment. During this assessment, participants completed measures of smoking behaviors, physical and mental health, cognitive function, and other factors related to smoking.

Eligible participants were invited to return for a 2.5 hour in-person MRI assessment session at the University of Georgia (UGA) BioImaging Research Center (BIRC). Baseline visits were scheduled one week before initiating treatment, and participants were instructed to smoke as usual for their baseline visit. After reviewing and completing informed consent, participants completed measures of smoking behaviors and goals, cigarette craving, impulsivity, and beliefs about control. Given that a goal of the parent study was studying neural correlates of smoking cessation, participants then completed 90 minutes of fMRI scanning, during which they completed tasks that measured craving, working memory, and impulsivity, including a DD task adapted from the MCQ for fMRI.

Following the baseline assessments and fMRI scanning, participants were invited to complete a 9-week smoking cessation treatment course that involved both in-person individual therapy sessions and nicotine replacement therapy in the form of nicotine patches. Participants' first session was scheduled after their baseline assessment and before their quit date. Session one was 60 minutes long and included counseling on quitting and distribution of both self-help materials and nicotine patches. Participants were provided with two-week supplies of Nicoderm CQ patches that were supplemented at each subsequent treatment session (one patch per day; four weeks at 21mg, two weeks at 14mg, and two weeks at 7mg). Following their first treatment session, participants were then scheduled for a 30-minute treatment session on quit day and 30-minute weekly treatment sessions for seven more weeks thereafter. All therapists were masters-level trained clinicians practicing under the supervision of a licensed clinical psychologist.

Cognitive behavioral therapy techniques were used, and therapy sessions were provided at no cost to participants (Fiore et al., 2008).

Treatment outcomes were monitored weekly using timeline follow back procedures, self-reports, and biochemical verification of smoking status. Smoking status was verified at each session using exhaled carbon monoxide (CO) measured with a PiCO+Smokerlyzer (Bedfont Scientific Ltd., Rochester, UK). One week after their ninth treatment session, participants were scheduled for a final, two-hour in-person follow-up assessment of smoking behaviors, craving, beliefs, and changes after treatment. Short telephone follow-up assessments were performed four and twelve weeks later to measure the presence and intensity of smoking behaviors and craving.

Measures

The primary measures to be used in this study were selected to assess trait impulsivity, impulsive behavior, smoking cessation self-efficacy, and treatment outcomes. Given the scope of the parent study, several additional measures will be available, if needed for additional experimental control.

Baseline measures. Several baseline variables were measured for potential confounding effects or explanatory value. In addition to demographic information, smoking severity (Fagerstrom Test of Nicotine Dependence, FTND, Heatherton, et al., 1991), depressive symptoms and affect (Patient Health Questionnaire, PHQ, Gilbody et al., 2007; Positive and Negative Affect Scales, PANAS, Watson et al., 1988), other substance use (Alcohol Use Disorders Identification Test, AUDIT, Saunders et al., 1993) were also assessed using both subjective self-report questionnaires and neuropsychological testing. These measures will be

examined for potential confounding effects in correlational analyses and controlled as covariates if necessary.

Primary Study Measures

Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency (UPPS-P) impulsive behavior scale. The UPPS-P is a 59-item assessment of five different domains of trait-impulsivity. Specifically, the UPPS-P measures negative urgency (acting impulsively when feeling strong negative emotions), positive urgency (acting impulsively when feeling strong positive emotions), lack of premeditation (acting without thinking), lack of perseverance (difficulty staying focused on tasks), and sensation seeking (gravitation toward new, exciting experiences; Whiteside and Lynam, 2001; Cyders et al, 2007). Taken together, these domains capture precise divisions of impulsivity that may better predict different types of impulsive behaviors than a broad, monolithic approach alone (Cyders et al., 2007). Positive and negative urgency measured via the UPPS-P will be used as measures of trait impulsivity in this study.

Smoking Self Efficacy Questionnaire (SEQ). The SEQ is a twelve-item self-report questionnaire designed to assess smokers' confidence in their ability to refrain from smoking in different situations. Each of the twelve items on the SEQ probe smokers to consider their expected ability to abstain from smoking on a scale of 1 (not at all sure) to 5 (absolutely sure). Items on the SEQ may be grouped either internal or external stimuli that may trigger craving, such as habit and negative affect, or environment and social situations.

The SEQ demonstrates high item-scale correlations, indicating high internal consistency. Further, this scale also exhibits strong construct and predictive validity, high test-retest

reliability, and low social desirability bias (Etter et al., 2000). In the present study, scores on the SEQ will be used first as a primary dependent variable in initial analysis, and then to measure the possible mediating effect of self-efficacy between trait impulsivity and subsequent treatment outcomes.

Delay Discounting.

Monetary Choice Questionnaire (MCQ). The MCQ is a brief measure of delay discounting (DD): a phenomenon of reduced perceived value of a reward as the time required to receive it increases. Typically regarded as a behavioral assessment of reward impulsivity, the MCQ measures DD by asking individuals to make a series of 27 choices between a small, immediate rewards and large, delayed rewards. The degree of discounting, or "k-value," can then be calculated based on individual respondents' preference for immediate or delayed rewards, such that higher k-values represent higher reactivity to delays and greater preference for immediate rewards (Odum, 2011).

The MCQ has been widely applied in addiction and other impulsivity research since its development in 1999, and has exceptional external validity. Specifically, discounting rates generated by responses on the MCQ in a laboratory setting are generally reliable predictors of actual reward-seeking and behavior (Kaplan et al., 2016). Impulsive behavior, indicated by MCQ discounting rates, will be examined as a potential moderator of the effects of trait impulsivity on self-efficacy in this study, and it will be evaluated along with DD for use as one component in a combined impulsive behavior composite.

Delay Discounting neuroimaging paradigm. The DD neuroimaging paradigm is an adaption of the MCQ for use in fMRI. During the DD neuroimaging paradigm participants make

choices between smaller immediate rewards or larger delayed rewards over a series of 72 items. Following the MCQ format, participants are presented each item (i.e., written question) via a pair of LCD goggles, and respond to each prompt using a handheld button box. Each item has a temporal discounting function and the overall pattern of the participants' responses allows for calculation of their discounting levels, or k-values, using the same method used to score the MCQ. After completing the task, participants received a monetary reward equal to one of their choices. The monetary reward was randomly selected out of all of the participant's responses. The DD task will be examined for convergent validity with the MCQ and potentially in a composite measure of impulsive behavior (Hypothesis 2).

Quantification of a combined measure of impulsive behavior. Because the parent study includes two measures of DD that each result in k-values, the MCQ and DD scores will be examined for convergent validity. As it is hypothesized that the neuroimaging DD will be highly consistent with the MCQ, k-values from each measure will be averaged per participant to yield a composite measure of impulsive behavior. If k-values are unexpectedly inconsistent across assessments, relationships between the MCQ and DD will be examined as they relate to self-efficacy (Hypothesis 1) and outcome (Hypothesis 3) separately.

Response to treatment. Participant outcomes were monitored over the course of the 9-week treatment plan, at the end of treatment, and again after four and twelve weeks. Outcomes monitored include smoking behavior, craving, and withdrawal. End of treatment outcomes will be used in Hypothesis 3 testing.

Smoking behavior was measured using a weekly Timeline Followback (TLFB) assessment where participants were asked to report daily smoking behaviors over the past week

(i.e., number of cigarettes smoked, if any). The TLFB is widely used, reliable and valid retrospective report of smoking that was developed as a concise, time-limited measure of substance use behaviors (Brown et al., 1998; Sobell and Sobell, 1992). Over the treatment period, it yields several outcome measures, such as lapse, relapse and abstinence, in addition to number of cigarettes smoked and days until lapse and relapse. The primary outcome measure used in this study will be "adherent abstinence" (*abstinent*; i.e., completed treatment and did not smoke for any period of seven concurrent days or more) versus "non-adherent/relapse" (*relapse*; i.e., smoking for seven concurrent days or longer during the intervention *or* dropping out of study). Should the *abstinent/relapse* grouping not provide sufficient statistical power, *time to relapse* will be used as the primary outcome variable in dimensional analyses. *Time to relapse* is defined as the number of days until participants have met criteria for a relapse, *or* until the final treatment session before the participant drops out of treatment.

In addition to the TLFB, smoking status was biochemically verified each week using exhaled carbon monoxide (CO) measured with a PiCO+Smokerlyzer (Bedfont Scientific Ltd., Rochester, UK). Exhaled CO levels of 10 parts per million or higher indicated current smoking (Daveci et al., 2004; Wald et al., 1981).

Other treatment-related variables. Several treatment-related measures were assessed during weekly treatment sessions and will be monitored for confounding effects or explanatory value in data analyses. Craving, self-efficacy, and commitment were queried during each session. Withdrawal was assessed using the Minnesota Tobacco Withdrawal Scale (MNWS), which shows good internal consistency and strong external validity when applied to smoking outcomes (Hughes and Hatsukami, 1986).

Statistical Analyses

Three sets of statistical procedures were conducted to test three hypotheses. The statistical threshold for all analyses for Hypotheses 1 and 3 was set at a two-tailed $p < 0.05$. Hypothesis 2 used established cutoffs for poor (less than .3), adequate (.3-.6), or very good (greater than .6) convergent validity indicated by absolute correlation coefficients (Cohen, 1988; Cohen, 1992; Hemphill, 2003). Data were analyzed using Statistical Package for the Social Sciences (SPSS; version 27).

Hypothesis 1: Test of the predicted negative relationship between self-reported versus behavioral measures of impulsivity and self-efficacy.

Multiple linear regressions were performed to determine whether a behavioral measure of impulsivity (i.e., MCQ) exacerbates the expected negative effects of self-reported impulsivity (i.e., positive and negative urgency scores on the UPPS-P) on self-reported self-efficacy (i.e., SEQ scores), while controlling for age, gender, and smoking severity (i.e., cigarettes per day), prior to enrollment in smoking cessation treatment. Two-way interactions between MCQ scores and each, negative urgency and positive urgency were examined. Six outliers in MCQ scores (>2.5 standard deviations from the mean) were Winsorized to limit influence on the distribution (Dixon, 1960).

Hypothesis 2: Test of convergent validity between two measures of impulsive behavior.

A Pearson correlation coefficient was generated to compare convergence between the out-of-scanner measure of impulsive behavior (i.e., k-values on the MCQ) and the in-scanner measure of impulsive behavior (i.e., k-values on the in-scanner DD task). Absolute correlation

coefficients less than .3 were considered *poor* convergent validity, .3–.6 *adequate*, and .6 or greater *good to very good*. These values were selected as more rigorous cutoffs than widely-known values (Cohen, 1988; Cohen, 1992; Hemphill, 2003). A correlation greater than .3 was established as a cutoff for evidence of convergent validity between the MCQ and in-scanner DD and support for combining both measures into one composite score representing impulsive behavior.

Hypothesis 3. Test of relationship between self-efficacy, self-reported trait versus observed behavioral measures of impulsivity, and smoking cessation outcomes.

Multiple logistic regressions were performed to examine three-way interaction effects of behavioral measures of behavioral impulsivity (i.e., MCQ and DD), self-reported impulsivity (i.e., positive and negative urgency scores on the UPPS-P), and self-reported self-efficacy (i.e., SEQ scores) on nine-week (end of treatment) smoking abstinence, while controlling for age, gender, and smoking severity (i.e., cigarettes per day): specifically, whether trait impulsivity's expected negative effect on smoking cessation will be attenuated by self-efficacy and exacerbated by levels of impulsive behavior.

CHAPTER 3

RESULTS

Demographics: A total of 122 participants reported for an initial eligibility intake, where they completed the SEQ, UPPS-P, and MCQ (see Table 2). Out of these participants (39.2% female), 53.7% were White, 39.8% were Black or African American, 0.8% were Asian American, 0.8% were Hispanic or Latinx, and 2.4% identified as other racial or ethnic group. The mean age of this sample was 40.840 years old (*SD* = 11.067), and participants generally were high school educated (*M* years of education = 13.080, *SD* = 2.390). Participants in this sample reported smoking an average of 20.983 cigarettes per day (*SD* = 14.220) and scored on average 4.970 out of 10 on the FTND (*SD* = 2.327), constituting a "medium level of dependence on nicotine" (*SD* = 2.476) (Heatherton et al., 1991; Pomerleau et al., 1989). After checking for missing data and outliers, 105 cases were included in Hypothesis 1 analyses.

Most of the participants who presented for an eligibility intake were either excluded on the basis of not meeting criteria for the treatment study inclusion, including MRI contraindications, or could otherwise not be reached for follow-up. A total of 55 participants were enrolled in the study after the eligibility intake, completed the second assessment that included the DD functional MRI (fMRI) paradigm, and initiated smoking cessation treatment. Out of these 55 participants (32.1% female), 64.3% were White, 26.8% were Black or African American, and 3.6% identified as other race or ethnicity. No participants in this sample identified as Asian American or Hispanic or Latinx. The mean age of this sample was 41.060 years old (*SD* = 11.397), and participants were generally high school educated (*M* years of education = 13.430,

SD = 2.089). Participants in this sample reported smoking an average of 22.811 cigarettes per day (*SD* = 14.622) and scored on average 5.060 out of 10 on the FTND, constituting a "medium level of dependence on nicotine" (*SD* = 2.476) (Heatherton et al., 1991; Pomerleau et al., 1989).

Exactly 40% (22) of participants were considered abstinent without relapse at the final treatment session, meaning they completed treatment without engaging in any period of 7 consecutive days of smoking. Only 9 participants, or 16% of the sample that engaged in treatment, completed treatment without any smoking (i.e., lapse), meaning the other 84% of the sample smoked at least once during the study. A total of 33 participants, or 60% of enrolled participants, dropped out or relapsed before treatment completion, 81% of which relapsed in the first week of treatment. After excluding cases with missing data, 41 cases were included in Hypothesis 2 analyses, and 40 were included in Hypothesis 3 analyses. Characteristics of this sample used to test Hypothesis 3 are listed by treatment outcome in Table 3.

Hypothesis 1: Test of predicted negative relationship between self-reported versus behavioral measures of impulsivity and self-efficacy.

Multiple linear regressions predicting SEQ scores were performed (n = 105) to explore the effects of impulsive behavior (i.e., MCQ scores) and its interactions with positive and negative urgency. The first model including age, gender, cigarettes per day, positive urgency, impulsive behavior (i.e., MCQ scores), and the interaction between positive urgency and impulsive behavior accounted for 8% of the variance around the mean of SEQ scores (R^2 = 0.080; see Table 4). Analyses revealed that the two-way interaction between positive urgency and impulsive behavior exhibited a small effect size that was not statistically significant. The main effects of positive urgency and MCQ were each in the predicted direction, but neither

reached statistical significance. There were also no significant main effects of gender or cigarettes per day. There was, however, a significant negative effect of the covariate age on SEQ scores such that older participants reported lower smoking self-efficacy.

The second model including age, gender, cigarettes per day, negative urgency, impulsive behavior (i.e., MCQ scores), and the interaction between negative urgency and impulsive behavior accounted for 12.8% of the variance around the mean of SEQ scores (R^2 = 0.128; see Table 5), an increase from the previous model utilizing positive urgency. The two-way interaction between negative urgency and impulsive behavior likewise exhibited a small, though not statistically significant, effect size. The main effects of negative urgency and MCQ were each in the predicted direction, but neither reached statistical significance. There were no significant main effects of gender or cigarettes per day. There was, again, a significant negative effect of the covariate age on SEQ scores such that older participants reported lower smoking self-efficacy.

Because the MCQ unexpectedly did not yield a significant main effect on SEQ scores, Hypothesis 1 was repeated using the subsample of 40 with DD k-values in place of MCQ scores. Model three, including age, gender, cigarettes per day, positive urgency, impulsive behavior (i.e., DD k-values) and the interaction between positive urgency and DD-indicated impulsive behavior accounted for 7.8% of the variance around the mean of SEQ scores (R^2 = 0.078; see Table 6). Analyses revealed that the two-way interaction between positive urgency and DD-indicated impulsive behavior was not statistically significant, and there were no significant main effects of positive urgency, impulsive behavior, age, gender, or cigarettes per day.

Model four, including age, gender, cigarettes per day, negative urgency, impulsive behavior (i.e., DD k-values) and the interaction between negative urgency and DD-indicated

impulsive behavior accounted for 10% of the variance around the mean of SEQ scores (R^2 = 0.100; see Table 7). Analyses revealed that the two-way interaction between negative urgency and DD-indicated impulsive behavior was not statistically significant, and there were no significant main effects of negative urgency, impulsive behavior, age, gender, or cigarettes per day.

Hypothesis 2: Test of convergent validity between two measures of impulsive behavior.

A Pearson correlation coefficient between MCQ and in-scanner DD k-values unexpectedly demonstrated poor convergent validity ($r = 0.220$, $p = 0.168$), indicating that it would not be appropriate to average the measures into a composite measure of impulsive choice in subsequent analyses. Given this, subsequent analyses were performed using both measures separately to predict outcomes.

Hypothesis 3. Test of relationship between self-efficacy, self-reported trait versus observed behavioral measures of impulsivity, and smoking cessation outcomes.

Because such a large proportion of those who relapsed did so in the first week of the study (i.e., 27 out of 33, or 81% of those who relapsed), the "time to relapse" variable was still essentially a binary outcome of immediate relapse to abstinence. As such, binary treatment adherent/"abstinent" versus treatment nonadherent/"relapse" was maintained as the primary outcome variable in Hypothesis 3.

Multiple logistic regressions were performed to examine relationships between trait impulsivity (i.e., positive versus negative urgency), impulsive behavior (i.e., MCQ versus DD k-values), and self-efficacy (i.e., SEQ scores) as predictors of smoking cessation outcomes (i.e.,

abstinence or relapse). The first logistic regression model including age, gender, cigarettes per day, positive urgency, impulsive behavior (i.e., MCQ k-values), self-efficacy, and the interaction between positive urgency, impulsive behavior, and self-efficacy accounted for 29.4% of the variance in outcome (Nagelkerke $R^2 = 0.294$; see Table 9). Analyses revealed that the three-way interaction between positive urgency, impulsive behavior, and self-efficacy was a relatively weak predictor in the model and was not statistically significant. There were no significant main effects of positive urgency, self-efficacy, age, gender, or cigarettes per day. The main effect of impulsive behavior was relatively much stronger than other predictors in the model, but also not significant.

The second logistic regression model including age, gender, cigarettes per day, negative urgency, impulsive behavior (i.e., MCQ k-values), self-efficacy, and the interaction between negative urgency, impulsive behavior, and self-efficacy accounted for 34% of the variance in outcomes (Nagelkerke $R^2 = 0.340$; see Table 10). Analyses revealed that the three-way interaction between negative urgency, impulsive behavior, and self-efficacy was a relatively weak predictor in the model and was not statistically significant. There were no significant main effects of negative urgency, self-efficacy, age, gender, or cigarettes per day. The main effect of impulsive behavior was, again, relatively much stronger than other predictors in the model, but still not statistically significant.

As in Hypothesis 1, and supported by results from Hypothesis 2, analyses were repeated using DD k-values in place of the MCQ. Logistic regression model three, including age, gender, cigarettes per day, positive urgency, impulsive behavior (i.e., in-scanner DD k-values), self-efficacy, and the interaction between positive urgency, impulsive behavior, and self-efficacy accounted for only 21% of the variance around the mean of outcomes (Nagelkerke $R^2 = 0.210$;

see Table 11). Analyses revealed that the three-way interaction between positive urgency, impulsive behavior, and self-efficacy was a relatively weak predictor in the model and was not statistically significant. There were no significant main effects of positive urgency, impulsive behavior, self-efficacy, age, gender, or cigarettes per day. In this model, impulsive behavior was a relatively strong predictor of outcome, but not statistically significant nor in the expected direction.

The final logistic regression, model four, including age, gender, cigarettes per day, negative urgency, impulsive behavior (i.e., in-scanner DD k-values), self-efficacy, and the interaction between negative urgency, impulsive behavior, and self-efficacy accounted for 22.6% of the variance around the mean of outcomes (Nagelkerke R^2 = 0.226; see Table 12). Analyses revealed that the three-way interaction between negative urgency, impulsive behavior, and self-efficacy was a relatively weak predictor in the model and was not statistically significant. There were no significant main effects of negative urgency, self-efficacy, age, gender, or cigarettes per day. The main effect of impulsive behavior was relatively much stronger than other predictors in the model, but also not significant.

Power Analysis

Hypothesis 1. A power analysis was conducted using 80% power, two-tailed 5% type I error rate, and a sample size of 105 (i.e., the total number of participants who completed the baseline assessment with valid data for all tests). With three covariates, one interaction term, and two main effects (i.e., six total predictors) this study was adequately powered to detect an effect size f^2 of 0.138. This means that the proposed sample size was sufficiently powered to detect small effect sizes.

Repeating a power analysis using 80% power, two tailed 5% type I error rate, and a sample size of 40 (i.e., the total number of participants who completed the DD task during a visit one week after intake with valid data for all tests). With three covariates, one interaction term, and two main effects (i.e., six total predictors) this study was adequately powered to detect an effect size f^2 of 0.410. This means that the proposed sample size was sufficiently powered to detect large effect sizes.

Hypothesis 3. Given the logistic regression analyses employed does not allow complete power analysis, statistical power was estimated using a parallel linear regression model. Specifically, a power analysis was conducted using 80% power, two-tailed 5% type I error rate, and a sample size of 40 (i.e., the total number of participants who completed the in-scanner DD task at the follow-up visit one week after intake with valid data for all tests). With three covariates, one interaction term, and three main effects (i.e., seven total predictors) this study was adequately powered to detect an effect size f^2 of 0.443. This means that the proposed sample size was sufficiently powered to detect large effect sizes.

CHAPTER 4

DISCUSSION

The present study was designed to examine the interrelationships between trait impulsivity, impulsive behavior, and self-efficacy, and the degree to which they predict smoking cessation treatment success in a sample of adult heavy cigarette smokers who were motivated to quit. Although the proposed hypotheses were not supported, preliminary findings extend previous research examining the effects of impulsivity and self-efficacy on smoking cessation, contribute to understanding of impulsivity as a multidimensional construct, and support the use of multimeasure approaches when investigating factors associated with outcomes of evidence-based interventions.

Hypothesis 1 was not supported. Specifically, the interactions between trait impulsivity (i.e., positive or negative urgency) and impulsive behavior (i.e., MCQ scores) were not significant. However, it was found that the model including negative urgency and its interaction with MCQ-indicated that behavioral impulsivity accounted for more of the variance in predicting lower self-efficacy than did the model with positive urgency. Results of the follow-up analyses using DD as the behavioral impulsivity measure revealed that it was not significantly related to smoking self-efficacy. Unlike the primary analyses for Hypothesis 1, DD behavioral impulsivity, nor its interactions with positive or negative urgency, did not directly predict smoking self-efficacy. Across all Hypothesis 1 analyses, the covariate age emerged as either a significant or near-significant predictor of lower smoking self-efficacy both as a bivariate correlate and when

entered into the multivariate regression models including gender, cigarettes per day, and trait and behavioral impulsivity.

There are many possible reasons why negative urgency, a subscale of trait impulsivity, emerged in the primary analyses as a relatively stronger predictor of self-efficacy than impulsive behavior or positive urgency. Integrative models of SUDs posit that attempts to reduce or avoid negative affect lead to longer-term alterations in self-perception and lack of confidence in one's ability to quit using substances, which offers insight into the relative strength of negative urgency as it relates to self-efficacy in the present analyses (Carmody et al., 2007; Rae, 2014). Conversely, the lack of a significant relationship between positive urgency and smoking self-efficacy is unexpected, given that the desire to amplify or extend positive affect is a widely-cited reason for substance use (Cyders et al., 2007). However, despite its potential to trigger impulsive substance use, positive affect is also generally associated with higher levels of self-efficacy (Schutte, 2013). It is possible that increased sensitivity to positive affect could attenuate the negative effects of impulsivity through the protective effects of positive affect itself, thus being less of a detriment to self-efficacy than negative urgency.

The lack of direct effects of either measure of behavioral impulsivity and smoking self-efficacy was unexpected. One possible reason for this was mismatched assessment modalities. While observed behavior reliably predicts subsequent behavior in smokers better than self-reports, it is possible that the present study did not detect links between impulsivity measured behaviorally and self-efficacy measured by self-report (Berg et al., 2015; Sharma et al., 2013). If this interpretation is correct, then it is also possible that the common method of assessment between trait impulsivity and self-efficacy, namely retrospective self-reports, may share bias

related to individual insight and self-perception, thus confounding assessment in a way that inflates the strength of this relationship (Gosling et al., 1998).

The lack of direct behavioral impulsivity effects on self-efficacy in Hypothesis 1 analyses also prompted questions about the MCQ measure. Emerging research has begun to call into question the use of the MCQ in substance using populations because it results in ceiling effects in highly impulsive individuals, which could account for its nonsignificant association with self-efficacy (Towe et al., 2015). It was expected that replacing the MCQ in Hypothesis 1 with a longer assessment of behavioral impulsivity, namely the DD task, would confer an increase in statistical power given the increase in number of discounting items on this version. However, this potential gain in predictive power was limited by the reduced sample size of those with viable DD data compared to those who had completed the MCQ one week prior at intake, and no significant results were found. Further, interpretation of the MCQ and DD was limited given that both assessments are experimental measures without established norms and the study design did not include a normative control group (Amlung et al., 2017; MacKillop et al., 2011).

Although age is well-documented as being an important predictor of smoking cessation, the fact that it emerged as stronger than any other predictors of self-efficacy in Hypothesis 1 was unexpected. There are many possible reasons why age and self-efficacy were inversely correlated in the present analyses. First, it is well-documented that quit attempts increase with age, such that by the time smokers have reached age 65, they have likely already tried to quit smoking with limited success (Çiftci et al., 2018). This paradoxically lowers the likelihood of succeeding in subsequent quit attempts, seemingly through reduced self-efficacy resulting from prior failures (Borland et al., 1991; Wilcox et al., 1985). Second, given that smoking is associated with, and implicated in the development of, diseases that impair functioning and

autonomy in old age, such as diabetes, dementia, osteoporosis, and various types of cancer, it is possible that age-related disabilities, exacerbated by smoking, only amplify older adults' declining beliefs about their ability to function generally, let alone succeed in quitting smoking (Nicita-Mauro et al., 2008). In sum, it appears that the deleterious effects of age on health can have downstream consequences for self-efficacy, thus creating a cycle of learned helplessness.

Hypothesis 2 was not supported. Instead of demonstrating good convergent validity, the MCQ and DD exhibited a weaker relationship than expected. These findings provide support for Towe et al. (2015)'s findings that the MCQ may have limited capacity to assess elevated impulsive behavior in substance use. Given that the MCQ is a short measure of behavior, its predictive power is limited and confers a greater likelihood of observing ceiling effects in highly impulsive individuals. Therefore, it is reasonable to assume that extended measures of DD may more accurately and precisely represent actual patterns of impulsive behavior that would appear divergent from brief measures such as the MCQ. Even more broadly, it could also be that, like trait impulsivity, impulsive behavior is a highly plastic and complex multidimensional factor that is difficult to measure appropriately, and that it may vary to a greater extent by situation and time of assessment (Berg et al., 2015; Billieux et al., 2007; Bloom et al., 2014). However, as in Hypothesis 1, the mismatch in sample size between MCQ and DD not only limits the ability to compare the role of the two measures in the models studied, but also reduces the potential increase in predictive power conferred by the greater number of items on the DD task.

Hypothesis 3 was not supported. However, in testing which individual factors most strongly predicted smoking cessation outcomes after a nine-week course of CBT and NRT, several unexpected and novel findings emerged. First, positive urgency, as well as its interactions with self-efficacy and MCQ- or DD-indicated impulsive behavior, was not a significant predictor

of abstinence and was generally a relatively weaker predictor than others in each model. Second, age did not emerge as a significant covariate related to outcome as it did in Hypothesis 1 analyses related to self-efficacy. And finally, the model which accounted for the most variance in outcomes, and was the closest to reaching statistical significance, included negative urgency, self-efficacy, and MCQ-indicated impulsive behavior, but none of the predictors within this model were significant.

Overall, results of Hypothesis 3 analyses suggest that impulsive behavior, measured with the MCQ, self-efficacy, and trait negative urgency interactively account for large amounts of variance in smoking cessation outcomes, ranging from 20 to 34%, implying a degree of clinical significance. Despite their limited effects statistically, identification and intervention upon such prognostic factors could be beneficial in smoking cessation, even if the mechanistic processes underlying their effects are not yet entirely understood. However, it must be noted that in the present study, effects of empirically-derived predictors of outcomes did not always yield results in the expected direction or above and beyond the predictive power of other factors. For instance, all three-way interactions between trait impulsivity, self-efficacy, and impulsive behavior exhibited negative effects on outcome, indicating a greater likelihood of relapse, suggesting that the effects of impulsivity appear to overpower the potential attenuating effects of self-efficacy in smoking cessation. None of the main effects within these interactions reached the level of statistical significance, and only self-efficacy demonstrated directional effects consistent with hypotheses. Impulsive behavior, measured on the MCQ or DD paradigm, exhibited small effects opposite of expectations, where higher discounting predicted abstinence, but again did not achieve statistical significance.

Similar to Hypotheses 1 and 2, lack of support for Hypothesis 3 could be a result of methodological inconsistency across self-reports and behavioral tasks or conservative standards for hypothesis testing. Most notably, the statistical power for Hypothesis 3 predictions was limited. Further, it is possible that there were other covariates affecting the relationships between trait impulsivity, impulsive behavior, self-efficacy, and outcomes, such as race or ethnicity. Race and ethnicity have been documented to affect smoking behavior but were limited in representation in the present investigation (Derby et al., 1994; Lee and Kahende, 2007; Hymowitz et al., 1997; Polizzi et al., 2004). Finally, it is possible that the binary, rather than continuous, treatment outcomes examined in this study may not fully capture the intricacies of smoking cessation outcomes, which are well-documented as being complex and winding in their course (García-Rodríguez et al., 2013). The potential for dimensional analyses in this study was limited by the fact that such a large proportion of participants who relapsed did so immediately, essentially still yielding a binary outcome of "immediate relapse" or "abstinent" rather than a true continuum of length of abstinence.

Several notable patterns were observed in retention rates and outcomes. After enrolling in cessation treatment, 60% of participants relapsed before treatment completion and 40% of participants were abstinent at the conclusion of the study. This is consistent with documented failure rates of up to 60% and higher following a quit attempt (Bahadir et al., 2016; Fiore et al. 2008; García-Rodríguez et al. 2013). The observed success rate of 40% was above average, which could be related to several factors, including high motivation to quit as an inclusion criterion in the study, as well as utilization of what is currently considered the gold standard of treatment for smoking, including CBT and NRT. The rate of smoking lapse was high, nearly 84%, with only 9 maintaining complete abstinence during the course of treatment. This supports

prior literature demonstrating that smoking cessation as a nonlinear course (Centers for Disease Control, Smoking Cessation: Fast Facts, 2020; García-Rodríguez et al., 2013; U.S. Department of Health and Human Services, 2020).

Several factors must be considered when interpreting these treatment outcomes. Emerging evidence highlights the difficulty of selecting appropriately rigorous, well-matched treatment in smoking. Although there is historically strong evidence to support the use of CBT and NRT in smoking cessation, these methods are still also associated with significant dropout and limited long-term success (Bahadir et al., 2016; Fiore et al. 2008; García-Rodríguez et al. 2013). Because even this “gold standard” of treatment is limited in its long-term efficacy, it is possible that the treatment methods implemented in this study were limited by weaknesses in this approach as a whole. In response to such challenges in smoking cessation broadly, a growing body of evidence is beginning to explore the efficacy of novel interventions, such as mindfulness, in improving SUDs outcomes, especially as they may be moderated by self-efficacy (Brewer et al., 2011; Luberto et al., 2013). Though the efficacy of interventions such as mindfulness, compared to CBT, is not yet well-established, it is possible that the present study’s use of classic, yet limited treatment methods limited participants’ ability to generate significant reductions in trait impulsivity or impulsive behavior, or increases in self-efficacy, and thus no significant interactions between variables were found over the course of the study. Further, it is possible that the mechanisms by which impulsivity is known to influence smoking behaviors is not through self-efficacy, but rather another variable such as mindfulness skills.

While there were several strengths, including the prospective design, an effective cessation treatment, rigorous and conservative two-tailed statistical thresholds, and a multi-measure approach, the present study was limited by several factors. First, sample size and

statistical power were low, particularly for Hypotheses 2 and 3, and the potential for dimensional analyses was limited by an almost equal number of participants who relapsed immediately or remained abstinent for the entire study (Bahadir et al., 2016; Fiore et al. 2008; García-Rodríguez et al. 2013). Another major limitation is that both the MCQ and DD are experimental measures that do not yet have established norms related to impulsive behavior, and were unexpectedly weakly correlated (Amlung et al., 2017; MacKillop et al., 2014). While the present sample appears at face value to exhibit low overall discounting rates, dramatically limiting the predictive power of impulsive behavior in this study, the lack of MCQ or DD norms or a non-smoking control group limit the interpretability and generalizability of these findings (Reynolds et al., 2006; Sharma et al., 2013; Tomko et al., 2014; Wingrove and Bond, 1997). Further, lack of long-term follow-up data after treatment completion limits the ability to extrapolate findings to long-term treatment outcomes. Another notable limitation was the demographic composition of the sample. The majority of participants were White males. Previous research suggests that gender and race and ethnicity all play a role in predicting smoking status and responses to intervention (Derby et al., 1994; Hymowitz et al., 1997; Lee and Kahende, 2007). Thus, the narrow sample demographics may have limited the ability to generalize the present findings to broader populations.

In summary, findings provide preliminary evidence of the utility of a multi-trait approach to study impulsivity, supports the use of caution when selecting behavioral assessments of impulsivity, and suggests that trait impulsivity and impulsive behavior serve as important, likely interacting, factors influencing self-efficacy and its effects on smoking cessation. This research also highlights the difficulty of studying predictors of treatment outcomes based on inherently high relapse rates. Given that the present study was able to account for large amounts of variance

in outcome but was limited in establishing trait impulsivity, impulsive behavior, and self-efficacy as statistically significant predictors of smoking cessation, more research is needed to fully elucidate how these factors interact and what strategies may be used to mitigate them in clinical applications. To this point, future research should explore these interactions using a racially and ethnically diverse background, including individuals across many different levels of education and income, with a balance of males and females. Methodology should be rigorous and precise, including standardized and normed, objective, observational assessments where possible and experimental manipulation in the form of targeted and appropriately matched interventions, either focusing on impulsivity or self-efficacy, such that strong conclusions may be drawn about temporal precedence of change in the course of smoking cessation.

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TABLES

Table 1:
Timeline of Study

	Intake	In-person Research & Treatment Visits										Follow-up	
Week:	1	2	3	4	5	6	7	8	9	10	11	12	16	24
Eligibility Assessment	X													
Baseline Visit		X												
Treatment Visits			X	X	X	X	X	X	X	X	X			
In-person Follow-up												X		
Telephone Follow-up													X	X

Note: Eligibility criteria included 1) age 18-65, 2) self-reported smoking of at least 10 cigarettes per day, 3) self-reported 5 or greater on a 10-point motivation to quit scale, 4) no weekly or daily use of illicit substances within the past 90 days, 5) no history of major medical, psychiatric, or neurologic conditions, 6) no currently treated psychiatric disorders, and 7) no magnetic resonance imaging (MRI) contraindications.

Table 2:
Hypothesis 1, Sample Characteristics (n = 105)

	M	*S.D.*	Minimum	Maximum
1. Age	40.840	11.067	19	61
2. Cigs/day	20.983	14.221	3	90
3. PU	1.853	0.672	1.000	3.214
4. NU	2.284	0.667	1.000	3.583
5. SEQ	34.440	13.496	12	60
6. MCQ	0.038	0.051	0.001	0.248
7. DD	0.094	0.210	0.001	1.290

Note: Cigs/Day = number of cigarettes smoked per day; PU = Positive Urgency scores on the Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency (UPPS-P) scale; NU = Negative Urgency scores on the UPPS-P; SEQ = self-reported Smoking Self-Efficacy scores; MCQ = MCQ discounting rates (i.e., k-values); DD = Delay Discounting (i.e., discounting rates, or “k-values,” from in-scanner DD task).

Table 3:
Hypothesis 3, Sample Characteristics (n = 40)

	Relapse (n = 23)		Abstinence (n = 17)	
	M	*S.D.*	*M*	*S.D.*
1. Age	43.290	10.777	37.91	11.747
2. Cigs/day	26.194	16.838	18.045	9.151
3. PU	1.792	0.654	1.594	0.561
4. NU	2.243	0.681	2.011	0.540
5. SEQ	35.550	14.812	36.050	11.548
6. MCQ	0.044	0.055	0.029	0.046
7. DD	0.094	0.115	0.094	0.293

Note: Relapse = seven concurrent days of smoking *or* dropped out of treatment; Abstinence = no period of seven concurrent days of smoking *and* completed treatment; Cigs/Day = number of cigarettes smoked per day; PU = Positive Urgency scores on the Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency (UPPS-P) scale; NU = Negative Urgency scores on the UPPS-P; SEQ = self-reported Smoking Self-Efficacy scores; MCQ = Monetary Choice Questionnaire discounting rates (i.e., k-values); DD = Delay Discounting (i.e., discounting rates, or “k-values,” from in-scanner DD task); no significant differences.

Table 4:
Hypothesis 1, Model 1, Predicting Smoking Self-Efficacy (n = 105)

	Unstandardized Coefficients		Correlations	
	B	*S.E.*	Zero-Order	Partial
1. Gender	-2.543	2.790	-0.043	-0.092
2. Age	-0.312*	0.126	-0.196*	-0.243*
3. Cigs/day	0.144	0.104	0.063	0.137
4. PUxMCQ	-0.076	0.384	-0.121	-0.020
5. PU	-1.211	6.709	-0.079	-0.018
6. MCQ	-0.031	0.820	-0.079	-0.004
Constant	50.249	15.168	-	-

Note: Dependent Variable = self-reported Smoking Self-Efficacy scores (SEQ); Cigs/Day = number of cigarettes smoked per day; PU = Positive Urgency scores on the Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency (UPPS-P) scale; MCQ = Monetary Choice Questionnaire (number of impulsive choices); PUxMCQ = interaction between PU and MCQ; * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

Table 5:
Hypothesis 1, Model 2, Predicting Smoking Self-Efficacy (n = 105)

	Unstandardized Coefficients		Correlations	
	B	*S.E.*	Zero-Order	Partial
1. Gender	-1.943	2.724	-0.043	-0.072
2. Age	-0.325**	0.124	-0.196**	-0.257**
3. Cigs/day	0.165	0.099	0.063	0.165
4. NUxMCQ	-0.182	0.420	-0.213	-0.044
5. NU	-2.163	7.308	-0.205	-0.030
6. MCQ	0.215	1.032	-0.079	0.021
Constant	53.209	19.343	-	-

Note: Dependent Variable = self-reported Smoking Self-Efficacy scores (SEQ); Cigs/Day = number of cigarettes smoked per day; NU = Negative Urgency scores on the Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency (UPPS-P) scale; MCQ = Monetary Choice Questionnaire (number of impulsive responses); NUxMCQ = interaction between NU and MCQ; * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

Table 6:
Hypothesis 1, Model 3, Predicting Smoking Self-Efficacy (n = 40)

	Unstandardized Coefficients		Correlations	
	B	*S.E.*	Zero-Order	Partial
1. Gender	-0.021	4.907	0.038	-0.001
2. Age	-0.328	0.204	-0.276	-0.262
3. Cigs/day	-0.014	0.222	-0.087	-0.011
4. PUxDD	-0.248	24.330	-0.030	-0.002
5. PU	0.519	4.885	0.008	0.018
6. DD	2.923	56.983	-0.034	0.009
Constant	46.560	11.892	-	-

Note: Dependent Variable = self-reported Smoking Self-Efficacy scores (SEQ); Cigs/Day = number of cigarettes smoked per day; PU = Positive Urgency scores on the Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency (UPPS-P) scale; DD = Delay Discounting (i.e., discounting rates, or "k-values," from in-scanner DD task); PUxDD = interaction between PU and DD; * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

Table 7:
Hypothesis 1, Model 4, Predicting Smoking Self-Efficacy (n = 40)

	Unstandardized Coefficients		Correlations	
	B	*S.E.*	Zero-Order	Partial
1. Gender	-0.609	4.851	0.038	-0.021
2. Age	-0.348	0.203	-0.276	-0.279
3. Cigs/day	0.002	0.211	-0.087	0.001
4. NUxDD	10.994	29.328	-0.047	0.063
5. NU	-4.021	4.464	-0.140	-0.151
6. DD	-23.976	74.324	-0.034	-0.054
Constant	56.913	14.279	-	-

Note: Dependent Variable = self-reported Smoking Self-Efficacy scores (SEQ); Cigs/Day = number of cigarettes smoked per day; NU = Negative Urgency scores on the Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency (UPPS-P) scale; DD = Delay Discounting (i.e., discounting rates, or "k-values," from in-scanner DD task); NUxDD = interaction between NU and DD; * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

Table 8:
Hypothesis 1, Zero-Order Correlations Between Variables of Interest (n = 105)

	1	2	3	4	5	6	7
1. Gender	-						
2. Age	-0.122	-					
3. Cigs/Day	-0.063	0.279**	-				
4. PU	-0.061	-0.021	0.149	-			
5. NU	0.068	-0.049	0.127	0.748**	-		
6. SEQ	-0.027	-0.183*	0.046	-0.064	-0.198*	-	
7. MCQ	-0.054	0.009	-0.122	0.080	0.011	-0.061	-

Note: Cigs/Day = number of cigarettes smoked per day; PU = Positive Urgency scores on the Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency (UPPS-P) scale; NU = Negative Urgency scores on the UPPS-P; SEQ = self-reported Smoking Self-Efficacy scores; MCQ = Monetary Choice Questionnaire (number of impulsive responses); * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

Table 9:
Hypothesis 3, Model 1, Predicting Outcome (n = 40)

	Unstandardized Coefficients		
	B	*S.E.*	*Significance*
1. Gender	0.711	0.866	0.412
2. Age	-0.006	0.033	0.851
3. Cigs/day	-0.090	0.050	0.070
4. PUxSEQxMCQ	-0.397	0.409	0.331
5. PU	0.874	0.765	0.253
6. SEQ	0.032	0.037	0.394
7. MCQ	3.480	18.780	0.853
Constant	-0.347	2.545	0.892

Note: Dependent Variable = abstinence (no period of seven concurrent days of smoking *and* completed treatment); Cigs/Day = number of cigarettes smoked per day; PU = Positive Urgency scores on the Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency (UPPS-P) scale; SEQ = self-reported Smoking Self-Efficacy scores; MCQ = Monetary Choice Questionnaire discounting rates (i.e., k-values); PUxSEQxMCQ = interaction between PU, SEQ, and MCQ; * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

Table 10:
Hypothesis 3, Model 2, Predicting Outcome (n = 40)

	Unstandardized Coefficients		
	B	*S.E.*	*Significance*
1. Gender	0.642	0.905	0.479
2. Age	-0.016	0.033	0.625
3. Cigs/day	-0.077	0.049	0.115
4. NUxSEQxMCQ	-0.654	0.406	0.108
5. NU	0.140	0.680	0.837
6. SEQ	0.042	0.038	0.267
7. MCQ	17.233	21.845	0.430
Constant	0.781	3.022	0.796

Note: Dependent Variable = abstinence (no period of seven concurrent days of smoking *and* completed treatment); Cigs/Day = number of cigarettes smoked per day; NU = Negative Urgency scores on the Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency (UPPS-P) scale; SEQ = self-reported Smoking Self-Efficacy scores; MCQ = Monetary Choice Questionnaire discounting rates (i.e., k-values); NUxSEQxMCQ = interaction between NU, SEQ, and MCQ; * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

Table 11:
Hypothesis 3, Model 3, Predicting Outcome (n = 40)

	Unstandardized Coefficients		
	B	*S.E.*	*Significance*
1. Gender	0.091	0.784	0.907
2. Age	-0.023	0.032	0.466
3. Cigs/day	-0.072	0.043	0.089
4. PUxSEQxDD	-0.019	0.086	0.825
5. PU	0.372	0.736	0.614
6. SEQ	0.013	0.028	0.647
7. DD	2.184	5.704	0.702
Constant	1.007	2.316	0.664

Note: Dependent Variable = abstinence (no period of seven concurrent days of smoking *and* completed treatment); Cigs/Day = number of cigarettes smoked per day; PU = Positive Urgency scores on the Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency (UPPS-P) scale; SEQ = self-reported Smoking Self-Efficacy scores; DD = Delay Discounting (i.e., discounting rates, or "k-values," from in-scanner DD task); PUxSEQxDD = interaction between PU, SEQ, and DD; * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

Table 12:
Hypothesis 3, Model 4, Predicting Outcome (n = 40)

	Unstandardized Coefficients		
	B	*S.E.*	*Significance*
1. Gender	0.039	0.798	0.961
2. Age	-0.027	0.032	0.411
3. Cigs/day	-0.059	0.043	0.172
4. NUxSEQxDD	-0.078	0.162	0.630
5. NU	-0.193	0.660	0.770
6. SEQ	0.017	0.032	0.601
7. DD	6.543	11.052	0.554
Constant	1.751	2.886	0.544

Note: Dependent Variable = abstinence (no period of seven concurrent days of smoking *and* completed treatment); Cigs/Day = number of cigarettes smoked per day; NU = Negative Urgency scores on the Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency (UPPS-P) scale; SEQ = self-reported Smoking Self-Efficacy scores; DD = Delay Discounting (i.e., discounting rates, or “k-values,” from in-scanner DD task); NUxSEQxDD = interaction between NU, SEQ, and DD; * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

Table 13:
Hypothesis 3, Zero-Order Correlations Between Variables of Interest (n = 40)

	1	2	3	4	5	6	7	8	9
1. Gender	-								
2. Age	-0.155	-							
3. Cigs/Day	-0.161	0.271*	-						
4. PU	-0.083	0.087	0.435**	-					
5. NU	-0.057	0.017	0.278*	0.670**	-				
6. SEQ	0.005	-0.219	0.088	0.087	-0.88	-			
7. MCQ	0.390*	-0.018	0.086	0.073	0.006	0.095	-		
8. DD	-0.046	0.258	0.196	0.244	0.118	-0.034	0.220	-	
9. Abstinence	0.124	-0.235	-0.277*	-0.159	-0.183	0.018	-0.149	0.000	-

Note: Abstinence = no period of seven concurrent days of smoking *and* completed treatment; Cigs/Day = number of cigarettes smoked per day; PU = Positive Urgency scores on the Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency (UPPS-P) scale; NU = Negative Urgency scores on the UPPS-P; SEQ = self-reported Smoking Self-Efficacy scores; MCQ = Monetary Choice Questionnaire discounting rates (i.e., k-values); DD = Delay Discounting (i.e., discounting rates, or "k-values," from in-scanner DD task); * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.