ABSTRACT

Title of Document:	AN EXPERIMENTAL INVESTIGATION OF THE FUNCTIONAL RELATIONSHIP BETWEEN SOCIAL PHOBIA AND CIGARETTE SMOKING
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Individuals with Social Phobia (SP) represent a large group with elevated rates of cigarette smoking and cessation rates lower than that of individuals without psychopathology. For individuals with SP, cigarette smoking may be used to reduce social anxiety in anticipation of and during social situations, however, no study to date has experimentally examined this function. The aim of the current study was to experimentally examine the functional relationship between cigarette smoking and SP as a function of induced social stress. Results indicated that high SP individuals experienced significant decreases in negative affect following smoking a cigarette when experiencing social stress. This effect was specific to high SP individuals under social stress condition and was not observed among individuals average in SP or when examining changes in positive affect. Findings are discussed in the context of understanding risk factors for smoking initiation and maintenance as well the development of efficacious interventions.

AN EXPERIMENTAL INVESTIGATION OF THE FUNCTIONAL RELATIONSHIP BETWEEN SOCIAL PHOBIA AND CIGARETTE SMOKING.

By

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Chapter 1: Introduction

Cigarette Smoking

Cigarette smoking is the leading cause of death and disability in the United States, estimated to kill 443,000 people in the United States annually (CDC, 2008a). Smoking-related illness costs an estimated $96 billion in medical costs and $97 billion in lost productivity each year (CDC, 2008a). Further, for every individual who dies from a smoking-attributable cause, another 20 currently live with a serious smoking-related disease (CDC, 2008a). While recent efforts have focused on prevention as well as creating effective smoking cessation programs, one in five U.S. high school students and adults still smoke cigarettes (CDC, 2008b, 2009).

Smoking and psychological comorbidity

Of the 443,000 individuals who die annually due to smoking-related causes in the United States, individuals with psychological disorders account for 200,000 of these deaths, or approximately 45% (CDC, 2008a). In contrast, prevalence estimates suggest that 20% of adults in the U.S. are affected by psychological disorders during a given year (USDHHS, 1999). Thus, among smokers, the percentage of these individuals with psychopathology is higher than expected from the general population. Individuals with both past month and lifetime psychopathology quit smoking at rates lower than individuals without a history of psychopathology (Lasser et al., 2000). Further, this population of individuals with psychological disorders consumes 44% of cigarettes each year, making them an important target for prevention and intervention efforts (Schroeder & Morris, 2010).

Psychological comorbidities that may have a functional relationship with smoking, or those in which smoking may be used as a tool to cope with the disorder or manage symptoms of the disorder, may be of the greatest concern. Social Phobia (SP) is one disorder that may have a functional relationship with cigarette smoking. 12.1% of the U.S. population meets criteria for SP at some point in their life (Ruscio et al., 2008). Further, there are significantly greater rates of smoking among individuals with SP than among individuals without psychological comorbidities with 54.0% of individuals with SP being lifetime smokers and 35.9% of individuals with SP being current smokers (Lasser et al., 2000; Ruscio et al., 2008). Thus, 38 million people in the U.S. meet criteria for SP at some point in their lives and 20.5 million of these individuals are lifetime smokers, while 13.5 million are current smokers. Moreover, although 33.4% of individuals with SP successfully quit smoking, this is a percentage significantly lower than that of individuals without comorbid psychopathology (42.5%) (Lasser et al., 2000).

These data indicate that rates of smoking among individuals with SP are elevated and these individuals quit smoking at lower rates than individuals without concomitant psychopathology, but there is a need for targeted work examining the functional relationship between smoking and SP to better understand the nature of this comorbidity. In that vein, I will next present an overview of SP and then turn to consideration of the functional relationship between SP and cigarette smoking.

Social Phobia

Definition and prevalence

SP, also known as social anxiety disorder (SAD), is a disorder characterized by anxiety in situations involving potential interaction or scrutiny by others (such as while speaking, eating, or writing) (APA, 2000; Beidel, Rao, Scharfstein, Wong, & Alfano, 2010). Hallmarks of SP include low positive affect and behavioral inhibition, as well as difficulties with social discourse, few social relationships, and limited occupational range with occupational choice based on expectancy of social interaction (Beidel et al., 2010; Bruch, Fallon, & Heimberg, 2003). Along these lines, areas of associated functional impairment for individuals with SP cut across multiple domains including occupational, academic, and social impairments.

SP is the most common anxiety disorder and is one of the most prevalent psychological disorders, with the National Comorbidity Survey (NCS) replication indicating that lifetime prevalence of SP was surpassed only by major depressive disorder, alcohol abuse, and specific phobia (Kessler et al., 2005). Recent incidence rate estimates by Grant and colleagues (2008) suggest that the one-year incidence of SP is 0.32. Prevalence estimates for past year and lifetime SP are approximately 7.1% and 12.1% respectively (Kessler et al., 2005; Ruscio et al., 2008). SP exhibits substantial comorbidity with other mental health problems such as other anxiety disorders, mood disorders, impulse control disorders, and substance use disorders (Kessler et al., 2005; Mineka, Watson, & Clark, 1998; Ruscio et al., 2008). Research suggests that SP has an earlier onset than many other disorders, with the average age of onset between 13 and 15 years of age, though SP has been found in children as young as 8 (Beidel, Turner, & Morris, 1999; Magee, 1999). SP tends to persist into

adulthood, particularly without treatment and with an earlier age of onset (before the age of 11) (Ballenger et al., 1998; Chartier, Walker, & Stein, 2003).

Coping with Social Phobia through Cigarette Smoking

While approximately 21% of the US population smokes cigarettes, prevalence estimates of cigarette smoking in individuals with SP have been as high as 35.9% (Baker-Morissette, Gulliver, Wiegel, & Barlow, 2004; Dube, McClave, Caraballo, Kaufmann, & Pechacek, 2010; Himle, Thyer, & Fischer, 1988; Lasser et al., 2000; McCabe et al., 2004). In a sample of German adolescents and young adults, 5.1% of nicotine dependent smokers also met criteria for SP, whereas 2.3% of non-nicotine dependent smokers met criteria for SP and 1.9% of non-smokers met criteria for SP, with nicotine dependence defined using DSM-IV criteria (Nelson & Wittchen, 2000). It is important to note that these differences were not statistically significant, likely because this study did not specifically recruit and examine individuals with SP, thus the number of individuals with SP was small. Nonetheless, these results suggest that a relationship exists between SP and cigarette smoking, with smokers being more likely to meet criteria for SP. In a more recent study using a community sample of adolescents, a SP diagnosis was significantly associated with cigarette smoking for boys, but not for girls (Wu et al., 2010), an interesting finding considering that SP is equally prevalent in males and females (Grant et al., 2008).

Given the heightened symptoms of anxiety associated with social situations present in SP, individuals with SP may attempt to cope with this affective distress through cigarette smoking. This argument is supported by findings that regular cigarette smoking does not predict the later onset of SP, suggesting that increased

rates of smoking among individuals with SP is attributable to SP leading to cigarette smoking (Johnson et al., 2000). Considering the anxiolytic properties of nicotine, cigarette smoking may be a particularly relevant strategy for regulating anxiety tied to social fears for individuals with SP (Kassel & Unrod, 2000; Pomerleau, Turk, & Fertig, 1984). While cigarette smoking may be used as an anxiolytic to reduce feelings of distress in social situations, it has also been proposed that for individuals with SP, cigarette smoking may aid in increasing social contact with other smokers (McCabe et al., 2004; Wittchen, Stein, & Kessler, 1999). Considering the long-term, well-known health consequences of continued cigarette smoking, placing smoking as the leading cause of death and disability in the United States, this relationship between SP and cigarette smoking warrants investigation (USDHHS, 2004).

Two longitudinal studies exist that suggest that SP, as well as sub-threshold symptoms of SP (having at least one social fear), are related to the onset of nicotine dependence. Breslau, Novak, & Kessler (2004) examined the role of DSM-III-R psychiatric disorders in predicting the subsequent onset of daily smoking, smokers' progression to nicotine dependence, and the persistence of smoking by using the Tobacco Supplement of the NCS. Breslau and colleagues (2004) found that individuals with any history of SP (either current or past) were 1.5 times more likely to be daily smokers than individuals without a history of SP (OR: 1.5 (1.2-1.7)). Furthermore, individuals with past SP (but not active) were 2.8 times more likely to be daily smokers than individuals without past SP (OR: 2.8 (1.4-5.4)) and individuals with active SP were 1.3 times more likely to be daily smokers than individuals

without active SP (OR: 1.3 (1.1-1.6)). Thus, current as well as past SP placed individuals at a heightened risk of becoming regular cigarette smokers.

Second, another prospective, longitudinal study addressed the relationship between nicotine dependence and SP. Sonntag and colleagues (2000) investigated associations between SP and smoking behavior in a community sample of adolescents and young adults (age 14-24 at baseline) to explore whether SP predicts the first onset of cigarette smoking, regular smoking and the development of nicotine dependence. This study also examined the relationship between sub-threshold SP (having at least one social fear, but not meeting criteria for SP) and cigarette smoking. At baseline, among dependent regular smokers, 15.4% reported no social fears, 26.1% reported social fears, but did not meet criteria for SP, and 31.5% met criteria for SP. At the 4-year follow-up, individuals who were non-smokers or non-dependent smokers at baseline, but endorsed at least one social fear, had an increased risk of meeting criteria for nicotine dependence at the follow-up. Similar patterns emerged for occasional users and non-dependent regular smokers with social fears, but who did not have a SP diagnosis as well as for occasional users with a SP diagnosis, but these patterns did not reach statistical significance. Taken together with the study by Breslau and colleagues, these findings remain inconclusive but suggest that a relationship exists between SP and smoking and that SP, as well as sub-threshold SP, may predict the onset of nicotine dependence and that this relationship is evident across developmental periods. Although these studies provide evidence for a temporal relationship between SP and cigarette smoking, they do not test specific mechanisms by which cigarette smoking may be maintained in individuals with SP and do not aid

in understanding whether there is a particular function of cigarette smoking for those with SP. I next move to consideration of negative reinforcement as a framework through which cigarette smoking may serve a functional role for individuals with SP.

Negative Reinforcement Framework

In teasing apart potential mechanisms for the relationship between cigarette smoking and SP, a negative reinforcement model offers a relevant framework. Negative reinforcement models suggest that the motivational basis of addictive drug use is the reduction or avoidance of aversive internal states (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004). These aversive internal states may be related to withdrawal from nicotine, but may also be related to more general negative affect (NA). From a negative reinforcement framework, individuals with SP would smoke cigarettes in order to reduce or avoid feelings of distress in relation to social situations or in anticipation of social situations. There has been some support for this negative reinforcement link between SP and cigarette smoking in early adolescence prior to the onset of regular smoking such that adolescents high in SP report greater urge to smoke during peer interactions than adolescents without elevated SP symptoms (Henry, Jamner, & Whalen, 2012).

The relationship between NA and smoking outside of the context of SP has been well documented (Kassel, Stroud, & Paronis, 2003) and this relationship may be particularly important for individuals with SP who experience heightened NA in anticipation of and during social situations. Across studies, cigarette smokers have been found to exhibit trait characteristics that may confer a predisposition for higher levels of NA such as neuroticism and heightened levels of trait stress reaction (Kahler

et al., 2010; Welch & Poulton, 2009). In turn, these enduring personality characteristics may predispose a person to look for a source of affective control, such as cigarette smoking. Along these lines, as reviewed by Kassel and colleagues (2003), numerous studies have indicated that cigarette smokers cite NA control as a primary motivation for smoking cigarettes. For individuals with SP, this suggests that reducing NA broadly and social anxiety specifically may be an important consequence of smoking cigarettes. Interestingly, while smoking a cigarette has been found to relieve the acute effects of nicotine withdrawal, one form of NA-motivated smoking, findings relating to the relief of other forms of NA such as environmental stressors have been less clear. For instance, Perkins and colleagues (2010) found that smoking a cigarette reliably reduced NA following a period of abstinence, but less robust decreases in NA were seen following other NA inducing procedures such as a computer memory challenge task and having to give a speech in front of observers. However, other studies have found that stress manipulations increase cigarette craving (e.g., Buchmann et al., 2010; Childs & de Wit, 2010). Thus, while control of NA is widely reported as a primary motive for smoking cigarettes, this regulation of negative affect may be specific to certain forms of stressors. Further, this line of research has yet to be extended to individuals with SP or with elevated SP symptoms, a population for which NA may be a primary motive for smoking and reason why cigarette smoking is maintained over time.

Summary and Significance

Cigarette smoking is a prevalent, deadly, and costly behavior for which effective prevention and treatment programs are still lacking. Rates of cigarette

smoking are particularly elevated among individuals with psychopathology. Within this category of individuals with psychopathology, individuals with SP represent a large group with elevated rates of cigarette smoking who quit smoking at rates lower than that of individuals without psychopathology. These findings highlight cigarette smokers with SP as a particularly important group for further examination.

A negative reinforcement framework would suggest a link between SP and cigarette smoking. While little research exists examining the functional relationship between SP and cigarette smoking, negative reinforcement models of cigarette smoking suggest that a functional relationship would exist between SP and cigarette smoking. Moreover, negative reinforcement models of cigarette smoking suggest that the motivational basis of addictive drug use is the reduction or avoidance of aversive internal states. This process is particularly relevant for SP considering increased feelings of anxiety in response to social situations and the need to regulate this anxiety. Along these lines, control of NA by smoking cigarettes may be a reason why individuals with SP initiate tobacco use and maintain use over time.

Despite knowledge of a temporal relationship between SP and cigarette smoking and the presence of strong theory to suggest a functional relationship, research provides little guidance to determine if cigarettes are being used to regulate NA and reduce anxiety by individuals with SP in the context of social stress. Considering the long-term consequences of cigarette smoking, it is important to get a clear understanding of the functional relationship between cigarette smoking and SP in order to create targeted interventions and cessation programs in the future for individuals with SP.

Current Study

The primary aims of the current study are to examine the relationship between level of SP (high SP, healthy control with average SP) and cigarette smoking-related outcomes (smoking topography) as well as to examine the relationship between level of SP and NA as a function of induced social stress (neutral, stress). To address these questions, participants were recruited based on regular cigarette smoking and their level of SP and were categorized into either a high or average SP group. Participants were specifically screened to form the high SP and healthy control with average SP groups using a SP screening measure. If eligible for the study, participants attended two experimental sessions, one a neutral condition and the other a social stressor condition, with session order counterbalanced across participants. The social stressor involved participants expecting that they would be required to deliver a speech to a panel of judges who would judge their performance. After being told they would be giving a speech, but before actually giving the speech, smoking topography data was collected and participants completed a measure of affect. Participants self-reported NA and positive affect (PA) three times during each experimental session in order to assess changes in affect associated with condition and cigarette smoking. To our knowledge, this is the first experimental study to examine the relationship between SP and cigarette smoking. We propose:

Aim 1: To examine group differences (high SP, average SP) in smoking outcomes in response to two conditions (neutral, induced social stress) among individuals who smoke cigarettes.

Hypothesis: In response to a social stressor, smokers who are high in SP, compared to individuals who are average in SP, will have greater smoking outcomes evidenced by greater puff number, greater puff volume, and shorter interpuff interval during smoking topography measures. This difference will be evident within the high SP group compared to a neutral condition and between groups in the stressor condition, with no differences between groups in the neutral condition.

Aim 2: To examine group differences (high SP, average SP) in NA in response to two conditions (neutral, induced social stress) as a function of cigarette smoking among individuals who smoke cigarettes.

Hypothesis: The relationship between SP group and affect will vary as a function of condition. Individuals who are high in SP, compared to individuals who are average in SP, will exhibit significantly greater increases in NA in anticipation of a social stressor followed by significantly greater decreases in NA following smoking a cigarette when experiencing social stress.

Chapter 2: Research Design and Methods

Overall Design

A 2 x 2 mixed factorial design was used to examine changes in smoking topography outcomes (number of puffs, average volume, total volume, interpuff interval) and affect. For examining changes in smoking topography, condition (2; neutral, social stress) was the within-subject factor and SP level (high SP, average SP) was the between-subjects factor. For examining changes in affect, PANAS administration (3 administrations) was the within-subject factor and SP level (high SP, average SP) was the between-subjects factor. To explicate presentation of results, a data analytic plan for addressing these study aims is integrated within Chapter 3: Results.

Participants

Participants were recruited from the University of Maryland, College Park campus using flyers and postings on internet message boards and websites (e.g., campus listservs, Craigslist, Facebook). Half of the recruitment materials announced a study for cigarette smokers, while the other half of recruitment materials advertised a study for shy cigarette smokers. Interested individuals were advised to contact the study by phone or e-mail to complete an online screening to determine eligibility.

During the online screening, participants were asked demographic and psychiatric questions to determine their eligibility for the study. To be included in the study, participants had to report being current regular smokers between the ages of 18 and 21 meeting the following inclusion criteria: (1) smoked at least 5 cigarettes a day

for the past 6 months, (2) smoked 20 or more days out of the last 30 days, and (3) scored either above a 35 on the Social Interaction Anxiety Scale (SIAS; Mattick & Clarke, 1998) comprising the high SP group, or between a 9 and a 24 on the SIAS comprising the average SP group. The SIAS cutoff values are taken from the initial validation study of the scale in which Mattick and Clarke (1998) found that individuals with SP had a mean of 34.6 with a standard deviation of 16.4 on the SIAS and that undergraduate students had a mean of 19.4 with a standard deviation of 10.1. Thus, in the present study, to categorize between high and average SP groups, the high SP group was at or above the SP sample mean (above 35) and the average SP group was within 1 standard deviation below and 0.5 standard deviations above the undergraduate mean (9-24). The undergraduate norm was chosen rather than the community sample because the undergraduate sample is closest in age (mean age = 21.6 as compared to 32.2 for the community sample) to the targeted sample for the present study.

Measures

Measures assessed four domains including: 1) Smoking history and current smoking information, 2) Social phobia, 3) Affect, and 4) Smoking outcomes. Each measure is described in detail below.

Smoking History and Current Smoking Information

1. NCI Smoking History and Current Status Indices (Shumaker & Grunberg, 1986). Smoking history was assessed using the smoking history and current

status indices agreed upon by a NCI consensus panel (1986) including: rate, brand, nicotine content, previous quit attempts and duration, and onset age.

2. Modified Fagerstrom Tolerance Questionnaire (mFTQ, Prokhorov et al., 2000). Nicotine dependence was assessed using a modified version of the Fagerstrom tolerance questionnaire (mFTQ), which was developed specifically for adolescent smokers (Prokhorov et al., 2000). Previous research has demonstrated that this measure is valid and applicable to adolescent smokers (Kassel et al., 2007; Prokhorov et al., 2000).

3. Timeline Followback (Brown et al., 1998). Timeline Followback (TLFB) procedures were used to index number of cigarettes smoked. The TLFB procedure has good reliability and validity with adolescent (Lewis-Esquerre et al., 2005) and adult smokers (Brown et al., 1998). At session 1, TLFB information was collected for the past 30 days and at session 2, TLFB information was collected for the interim period since session 1.

Social Phobia

1. Social Interaction Anxiety Scale (SIAS; Mattick & Clarke, 1998). The SIAS is a 20-item measure designed to measure anxiety in response to situations involving interaction with others using a 5-point scale, ranging from 0 to 4 (e.g., not at all characteristic or true of me to extremely characteristic or true of me). The statements reflect the level of general anxiety associated with the initiation and maintenance of social interactions (e.g., meeting and talking to strangers, friends, or members of the opposite

sex). During initial validation, the SIAS was found to discriminate between individuals with SP and community subjects. In the present study, the SIAS was used as a screening and grouping measure to categorize participants based on SP level into one of two groups: high SP or average SP.

Affect

1. Positive and Negative Affect Scale (PANAS; Watson et al., 1988). The PANAS is a commonly used 20-item mood measure that assesses two global dimensions of affect: negative and positive. A large body of literature supports the validity of the PANAS (Watson, 2000). The scale assesses both positive affect (PA) and negative (NA) affect. PA reflects the extent to which a person feels enthusiastic, alert, and active while NA reflects a person's subjective distress and encompasses anger, contempt, disgust, and guilt. The PANAS commonly is used to detect changes in emotional reactions to stimuli in the manner proposed here and has been found to have good internal consistency (Cronbach's alpha = .86-.90 for PA, .84-.87 for NA; Crawford & Henry, 2004) and good construct, convergent and discriminant validity in clinical and non-clinical samples (Watson et al., 1988). The NA score was calculated by taking the sum of ratings for the 10 NA items. Likewise, the PA score was calculated by taking the average of ratings for the 10 PA items. The measure was administered three times during each session.

Smoking Outcomes

1. Smoking Topography (Hammond et al., 2005). CReSSmicro (Plowshare Technologies, Inc., Baltimore, MD) is a battery-operated portable device that measures a host of smoking topography variables (puff volume, puff number, puff duration, average flow, interpuff interval, time, and date). The device is small (2.5 x 2.2 x 1.2 inch, 3.1 oz), allowing independent use in the participant's natural environment. CReSSmicro uses an orifice flow meter mouthpiece to determine flow rate. All of the smoking topography variables are derived from the basic measurements of flow and time. Participants were allowed to smoke cigarettes through the CReSSmicro before and after the experimental manipulation in order to assess changes in smoking behavior between experimental sessions. From the basic topography measurements, we calculated four key variables of interest: 1) average volume, 2) total volume, 3) number of puffs, and 4) interpuff interval.

Assessment Procedures

The study consisted of two sessions held at the Center for Addictions, Personality and Emotion Research at the University of Maryland College Park. All procedures were approved by the University of Maryland's Institutional Review Board.

Screening

The online screening included questions about smoking behavior. Participants completed the SIAS (Mattick & Clarke, 1998) within the online screening. Demographic information such as date of birth, gender, ethnicity/race, marital status, and years of education were collected and re-confirmed at Session 1. If eligible for the study, participants were contacted via email or phone for scheduling and asked to bring at least two cigarettes of their preferred brand to each of the experimental sessions.

Experimental Sessions

Condition order was counterbalanced (neutral first or social stress first) and, with the exception of video content, the sessions followed identical procedures. Participants completed consent procedures at the beginning of their first experimental session. Following consent (during the first session) or at the beginning of the second session, participants were escorted outside and given the option to smoke a cigarette through the CReSSmicro smoking topography mouthpiece. The purpose of smoking this cigarette at the beginning of each session was to control for time since last cigarette smoked and to allow participants to acclimate to the topography mouthpiece. Participants then completed self-report measures (Smoking history or mFTQ, PANAS) in a separate room. During session 1, participants completed the TLFB for cigarettes smoked in the past month while, during session 2, participants completed the TLFB for the time between sessions 1 and 2. Because the mFTQ and NCI smoking history and current status indices are stable and not time sensitive, they were counterbalanced between sessions 1 and 2.

Following measure completion, participants watched a control video (nature video) or a social stressor video (a variant of the Trier Social Stress task (TSST) video). In the TSST video, participants were told that they would be giving a speech to a panel of judges who would judge the quality of their speech. Participants then completed the PANAS (administration 2). Next, participants were again escorted outside and given the option to smoke a cigarette through the CReSSmicro smoking topography mouthpiece. After smoking this second cigarette, participants again completed the PANAS (administration 3). At the end of the session, participants were debriefed and compensated for participation. For a schedule of the administration of measures, see Table i below.

Chapter 3: Results

Descriptive Findings

Participants

413 individuals completed the initial screening. Of these 413, 104 were eligible for the study (25.2%). Individuals who completed the screening, but who were not eligible, were ineligible due to their current smoking levels (n=140), SIAS scores (n=154), age (n=120), or due to deceitful/misleading responses on the screening (n=9). Of the 104 eligible, 73 participants (41.7% female, Age M(SD) = 19.75(1.18), n = 31 High SP) attended at least one of the experimental sessions. Two participants in the Average SP group did not attend a second experimental session and were not included in subsequent analyses. Participants were excluded from subsequent repeated measures ANOVA analyses due to missing or incomplete smoking topography data (n=14) or PANAS data (n=4). Reasons for missing or incomplete topography data included device malfunctions and participants choosing to smoke cigarettes that did not properly fit into the topography devices. Patterns of missing data did not significantly differ between SP groups. See Table ii for information regarding sample demographics.

Cigarette Smoking

Average cigarettes per smoking day (CPSD) was obtained via the TLFB by dividing the total number of cigarettes smoked in the last month by the total number of days on which the participant smoked in the last month. Average CPSD for the sample was M(SD)=7.43(4.72). On average, participants first smoked at age

15.83(2.45), began smoking weekly at age 17.57(1.54), and began smoking daily at age 18.28(1.31). Regarding nicotine dependence, levels were relatively low with 3.90(1.41) as the mean score on the mFTQ. High SP individuals (M(SD)=8.95(5.39)) reported on average smoking significantly more CPSD than low SP (M(SD)=6.29(3.83)) individuals (t(70)=-2.46, *p*=.04).

Puff Topography

Across the two experimental sessions, participants smoked up to four cigarettes (one in each session prior to video presentation (Cigarette 1) and one following video presentation (Cigarette 2)). The vast majority of participants decided to smoke each cigarette they were given the option to smoke (> 91.7%; for the number of participants who chose to smoke each cigarette, see Table iii). Four topography variables of interest were calculated from the puff topography data: 1) Total number of puffs for each cigarette, 2) Mean puff volume, defined as the average volume of all measured puffs, 3) Total puff volume, defined as the sum of all measured puff volumes, and 4) Mean interpuff interval (IPI), defined as the average amount of time between measured puffs. Greater tobacco self-administration would be indicated by more puffs, higher mean puff volume, higher total puff volume, and shorter IPI. Topography data for each cigarette is presented in Table iv below. There were no significant group differences (High vs Average SP) in any of the topography variables.

Affect

PA and NA items on the PANAS were summed to create PA and NA scores for each individual for each administration of the PANAS. Descriptive statistics for PA and NA can be found in Table v.

Data Analytic Plan and Data Analyses to Address Primary Study Aims

In order to address the study aims, we followed several data analytic steps which are each described in detail below. First, using repeated measures ANOVAs, we explored the impact of demographic variables (age, race/ethnicity, gender) and CPSD on the dependent variables of interest (NA, PA, topography variables). After determining covariates to be included in analyses to address the primary study aims, we used repeated measures ANOVA analyses to examine within and between group (High vs. Average SP) differences in the dependent variables of interest (smoking topography, NA, PA) as a function of condition (Neutral vs. Social Stress). Each analysis with corresponding results is described in detail below beginning with analyses to determine the inclusion of potential covariates and then moving to analyses to address each of the primary study aims.

Determining covariates in subsequent analyses

To determine whether demographic variables (age, race/ethnicity, gender) and CPSD should be included as covariates in subsequent analyses, we conducted several repeated measures ANOVAs (one per dependent variable) to examine the impact of each potential covariate (4 total) on each dependent variable of interest (4 topography variables, NA, PA). For these analyses, the dependent variables of interest were entered as the within-subjects variable and the potential covariates were entered as

covariates. There were no significant within-subjects effects of any of the potential covariates on any of the dependent variables (all p's >.05). As such, we did not include any of the demographic variables as covariates in subsequent analyses. However, for theoretical reasons, in order to ensure that group (High vs. Average SP) differences in CPSD were not driving associations between SP, condition, and outcome (PA, NA, topography), we included CPSD as a covariate in all subsequent analyses.

Primary Study Aim 1: To examine the relationship between level of SP (high SP, average SP) and cigarette smoking-related outcomes (smoking topography) as a function of condition (neutral, stress).

To address the first primary study aim to determine whether smoking outcomes differed between conditions based on SP level, one 2x2 mixed factorial repeated measures ANOVA covarying for CPSD was conducted for each topography variable of interest (average puff volume, total puff volume, number of puffs, interpuff interval) with smoking outcomes as the dependent variable, condition (2; neutral, social stress) as the within-subject variable, and SP level (2; high SP, average SP) as the between-subjects variable resulting in four total repeated measures ANOVAs. These analyses revealed no significant between- or within-subjects interactions between SP group and condition on topography variables (all p's >.05).

Primary Study Aim 2: To examine the relationship between level of SP and NA as a function of condition.

To address this study aim, we conducted two 3x2x2 repeated measures ANOVAs: one with NA as the dependent variable and one with PA as the dependent variable. We examined both NA and PA as dependent variables to determine whether: 1) there was a relationship between SP level, NA, and condition, and 2) if this relationship exists, whether it is specific to NA or consistent across both NA and PA regulation.

To facilitate presentation of results, changes in NA and PA presented below are referred to across three time points: post cigarette 1, pre cigarette 2, and post cigarette 2. For the neutral session, post cigarette 1 refers to the time period following smoking the first cigarette of the session and before watching the nature video, pre cigarette 2 refers to the time period between watching the nature video and smoking the second cigarette of the session, and post cigarette 2 refers to the period following smoking the second cigarette of the session. For the social stress session, post cigarette 1 refers to the time period following smoking the first cigarette of the session and before watching the Trier social stress video, pre cigarette 2 refers to the time following watching the Trier video while participants anticipated that they would be giving a speech to a panel of judges, but before smoking the second cigarette, and post cigarette 2 refers to the period following smoking the second cigarette while participants still expected that they would be delivering a speech (see Figure i).

NA Omnibus Repeated Measures ANOVA. To address the second primary study aim, a 3x2x2 mixed factorial repeated measures ANOVA was conducted. NA was the dependent variable, PANAS administration (3; post cigarette 1, pre cigarette 2, post cigarette 2) and condition (2; neutral, social stress) were the within-subjects variables, and SP level (2; high SP, average SP) was the between-subjects variable. CPSD was entered as a covariate. Beyond a significant main effect of SP status [($F(1, 66)=5.00$, $p =.03$], results indicated a significant three-way interaction of condition, time (PANAS administration), and SP status [($F(2, 66) = 5.33$, $p = .006$]. This interaction was probed separately for the neutral and stress conditions.

Neutral session. During the neutral session, there were no significant between- or within-subjects effects of SP group on NA. For a graphical depiction of the relationship between SP group and NA during the neutral session, see Figure ii below.

Social stress session. For ease of presentation, between- and within-subjects effects of SP group on NA during the social stress session are described separately below. See Figure iii below for a graphical depiction of the between- and within-subjects effects.

Between-subjects effects. In the social stress session, the SP groups differed at pre cigarette 2 and post cigarette 2. Specifically, High SP individuals reported significantly more NA [($F(1, 67)=6.73$, $p=.01$] than Average SP individuals at pre cigarette 2. These group differences held following smoking the second cigarette in the social stress session such that High SP individuals reported significantly more NA [($F(1, 67)=7.75$, $p=.01$] at post cigarette 2.

Within-subjects effects. In the social stress session, NA significantly changed over time indicated by significant within-subjects effects of SP group on NA from post cigarette 1 to pre cigarette 2 [(F(1, 67)=4.93, p=.03] and from pre cigarette 2 to post cigarette 2 [(F(1, 67)=4.22, p=.04]. To understand the nature of these effects, we further probed the interaction by running two separate repeated measures ANOVAs: one for the high SP group and one for the average SP group. For high SP individuals, NA significantly increased from post cigarette 1 to pre cigarette 2 [F(1,28)=6.59, p=.02] and then significantly decreased from pre cigarette 2 to post cigarette 2 [F(1,28)=4.35, p=.05]. The average SP group did not significantly change in level of NA during the social stress session.

PA Omnibus Repeated Measures ANOVA. Second, to determine whether the interaction between SP group and condition was unique to NA or consistent across both NA and PA regulation, a second 3x2x2 mixed factorial repeated measures ANOVA was conducted. PA was the dependent variable, PANAS administration (3; post cigarette 1, pre cigarette 2, post cigarette 2) and condition (2; neutral, social stress) were the within-subjects variables, and SP level (2; high SP, average SP) was the between-subjects variable. CPSD was entered as a covariate. Results indicated a significant three-way interaction of condition, time (PANAS administration), and SP status [(F(2, 66)=3.45, p=.04]. The main effect of SP status on PA was not significant [(F(1, 66)=2.81, p=.10]. This interaction was probed separately for the neutral and stress conditions.

To explore the nature of this within-subjects effect, similar to the previous analysis, we probed the interaction by conducting 2 additional repeated measures

ANOVAs (one per condition). For these analyses, PA was the dependent variable, PANAS administration (3; post cigarette 1, pre cigarette 2, post cigarette 2) was the within-subject variable, and SP level (2; high SP, average SP) was the between-subjects variable. CPSD was entered as a covariate. Results are described by session below.

Neutral session. During the neutral session, there were no significant within-subjects effects of SP group on PA. For a graphical depiction of the effect of the relationship between SP group and PA during the neutral session, see Figure iv below.

Social stress session. Despite the significant within-subjects effect in the omnibus test, there were no significant within-subjects effects of SP group on PA during the social stress session or during the neutral session. For a graphical depiction, see Figure v below.

Chapter 4: Discussion

Summary of Main Findings

The present study provided an experimental examination of the relationship between SP, social stress, cigarette smoking, and affect in order to understand the functional role of cigarette smoking for individuals with SP symptomatology. Previous epidemiological studies have suggested that there is a temporal relationship between SP and cigarette smoking such that SP precedes the onset of cigarette smoking (Breslau, Novak, Kessler, 2004; Johnson et al., 2000; Sonntag et al., 2004). Not only does SP represent a risk factor for the initiation of cigarette smoking, but individuals with SP also have more difficulty quitting smoking than individuals without a psychological comorbidity (Lasser et al., 2000). Thus, SP appears to be a unique risk factor for both the initiation and maintenance of cigarette smoking over time. Towards developing targeted prevention and cessation interventions for this high risk group, it is important to understand the functional role of cigarette smoking for individuals with SP. The present study attempted to fill this gap in this literature.

The first primary study aim was to examine group differences (high SP, average SP) in smoking behavior in response to two conditions (neutral, induced social stress) among individuals who smoke cigarettes. Consistent with literature among non-socially phobic smokers suggesting that cigarettes may be used as an anxiolytic when experiencing stress (Kassel & Unrod, 2000), we hypothesized that high SP participants would exhibit significantly higher smoking topography indices (increased puff volume, increased puff number, decreased interpuff interval) than

average SP participants in anticipation of a socially stressful situation (giving a speech to a panel of judges). This hypothesis was not supported. High and average SP individuals did not significantly differ in any smoking topography variables in anticipation of the social stressor. There are two plausible explanations for this finding. First, for the present study, we were interested in individuals between the ages of 18 and 21 and recruited a sample consisting of relatively light smokers with low levels of nicotine dependence. Because this was true of both groups, there might not have been enough variability in topography in anticipation of the stressor due to low levels of smoking and nicotine dependence among all participants. A second explanation for this finding is that the function of cigarette smoking among high SP individuals when experiencing social stress is to regulate NA and affect regulation operates independently from amount of nicotine consumed.

With the second primary study aim, we addressed the possibility of the relationship between SP and cigarette smoking being driven by affect regulation, which may operate independently from amount of nicotine consumed. Specifically, utilizing a negative reinforcement framework, we hypothesized that for high SP individuals, anticipation of a social stressor would significantly increase NA, while smoking a cigarette while still anticipating a social stressor would significantly decrease NA. We hypothesized that this effect would be unique to the high SP group in the social stress condition and would also be specific to NA. This hypothesis was supported. High SP individuals reported significant increases in NA when told they would have to give a speech to a panel of judges who would judge their performance. After smoking a cigarette, while still anticipating having to give a speech, the high SP

group reported significantly decreased NA from the prior time point. Average SP individuals did not report significantly higher NA in anticipation of the social stressor and did not report significant decreases in NA after smoking a cigarette. Further, this effect was specific to NA and was not observed when examining changes in PA. Taken together with results from the first study aim, this suggests that while high SP individuals do not change their smoking behavior when experiencing social stress, cigarette smoking helps to significantly reduce NA while experiencing social stress. Thus, NA regulation when experiencing social stress may be one factor that maintains cigarette smoking in individuals with SP or with elevated SP symptoms.

Results from primary study aims one and two extend the work of Perkins and colleagues (2010) who found that NA relief following cigarette smoking was not dependent on the nicotine content of a cigarette, but rather on the type of NA mood induction used and the measure used for assessing changes in affect. One of the mood induction paradigms used by Perkins and colleagues (2010) was similar to the social stress mood induction used in the present study in that participants were required to deliver two speeches to panels of judges. Perkins and colleagues (2010) found that during this mood induction, smoking attenuated NA as measured by the PANAS, but not on other measures of NA. The present study extends the findings of Perkins and colleagues (2010) to a high risk group of smokers, smokers with elevated symptoms of SP, in a mood induction paradigm specifically targeted toward the situation in which these smokers might smoke to relieve NA. As suggested by Perkins and colleagues (2010), the effects of smoking, especially in regards to NA, may not be due to the pharmacological effects of nicotine, but rather due to conditioned

responses and the reinforcement of these conditioned responses over time. With the results of the present study in mind, this conditioned response pattern may be critical for smokers with elevated SP symptoms in the context of social stress and may be key to the development of efficacious smoking prevention and smoking cessation interventions for this high risk group.

While NA regulation through cigarette smoking may be of great importance for individuals with SP in the context of social stress, there is reason to believe that this relationship is not unique to individuals with SP who are experiencing social stress, but rather may be a broader factor that serves to maintain tobacco use in smokers more broadly. Indeed, there is much support across the smoking literature for the role of negative affect regulation in maintaining cigarette use among smokers (Baker, Brandon, & Chassin, 2004; Brandon, 1994). This relationship may be uniquely important for smokers with threshold and subthreshold psychopathology, and has found support among a number of disorders including depression (Weinberger, George, & McKee, 2011), generalized anxiety disorder (Moylan, Jacka, Pasco, & Berk, 2013), panic disorder (Mitchell et al., 2012), and ADHD (McClernon & Kollins, 2008). As such, while many cessation programs for smokers with psychopathology have focused on disorder-specific treatments (i.e., Brown et al., 2001; MacPherson et al., 2010; Winhusen et al., 2010) a transdiagnostic approach specifically targeting the relationship between NA regulation and continued tobacco use may afford the greatest degree of applicability for smokers attempting to quit. For example, strategies from MacPherson and colleagues' Behavioral Activation Treatment for Smoking (BATS; 2010), which seeks to facilitate smoking cessation

through reductions in negative affect and increases in positive affect, may be useful in moving towards transdiagnostic cessation programs.

Limitations

Results from the present study should be interpreted with the following limitations in mind. First, participants in the study were relatively light smokers with low levels of nicotine dependence. They were also all undergraduate students between the ages of 18 and 21. It is unclear how these findings might generalize to heavier, more dependent smokers, or smokers of different ages. Additionally, it is unclear the extent to which the smoking characteristics of this group influenced participants' decisions to smoke the second cigarette in each experimental session. It is possible that the relatively low levels of smoking among this sample contributed to some of the participants choosing not to smoke the second cigarette in the experimental sessions. Second, we used a validated SP measure for categorizing our SP groups. While the cutoffs we used have been validated in previous studies to distinguish between individuals with and without SP (Mattick & Clark, 1998), we did not use a diagnostic interview in the present study so we cannot be certain that all individuals in our high SP would meet diagnostic criteria for SP. Third, participants smoked cigarettes of their own brand during experimental sessions. As such, we were unable to standardize cigarette nicotine content across participants. We made this experimental decision in order to mimic naturalistic smoking behavior. However, it is possible that there could have been group differences by condition in the amount of nicotine self-administered when given the option to smoke due to differences in nicotine content across cigarette brands.

Future Directions

There are a number of important future directions from this line of research which cluster around both experimental future directions as well as future prevention and cessation interventions. Regarding experimental next steps, there are a number of important candidate moderators which may help to better understand the relationship between SP, cigarette smoking, and negative affect regulation which we were unable to explore in the present study. Candidate moderators include gender, nicotine dependence, age, severity of SP symptoms, and nature of SP symptoms (i.e., social interaction anxiety vs. social performance anxiety and generalized vs. non-generalized SP). Additionally, to further explore the relationship between the pharmacologic effects of nicotine on NA and reinforcement-based learning on NA, future experimental studies could experimentally manipulate the nicotine content of cigarettes (using high vs. low yield nicotine containing cigarettes, for instance) to further disentangle this relationship. Third, in the present study, a small subset of the sample opted to not smoke the second cigarette during the experimental sessions. In order to capture smoking behavior of lower level smokers such as college-aged smokers, it will be important for future studies to consider how best to mimic naturalistic smoking patterns in the context of experimental design. Regarding prevention, the present study suggests that smoking may be maintained among socially phobic smokers due to NA regulation in the context of social stress associated with cigarette smoking. Keeping in mind that the onset of SP tends to precede the onset of cigarette smoking, preventative interventions incorporating NA regulation skills may be especially important for children and adolescents with SP or

with elevated symptoms of SP in order to decrease the likelihood of smoking initiation. Evidence-based treatments that have found empirical support for decreasing negative affect and, in turn, increasing positive affect (for example, Behavioral Activation) may be the best fits as preventative interventions for addressing this NA risk factor. Second, because socially phobic smokers have less success with quitting smoking than individuals without psychological comorbidity, NA regulation strategies specifically addressing social situations may be especially important for improving cessation rates among smokers with SP or with elevated SP symptoms. Evidenced-based strategies such as exposure therapy may be relevant here to demonstrate natural reductions in NA over time when not given the option to smoke a cigarette following social situations.

Conclusions

Cigarette smoking remains a major public health concern and the prevalence of smoking is higher and cessation rates are lower among individuals with SP when compared to individuals without psychological comorbidities. In order to create efficacious prevention and intervention programs for this high risk group, it is necessary to understand the functional role of cigarette smoking for socially phobic individuals. The present study is the first to our knowledge to experimentally examine the functional relationship between SP, cigarette smoking, and social stress and implicates the role of NA regulation in the context of social stress as a cigarette smoking maintaining factor for individuals with SP. While individuals high in SP did not smoke differently in the context of social stress as compared to a neutral condition or when compared to individuals average in SP, following smoking a cigarette when

experiencing social stress, high SP individuals experienced significantly reduced NA. This negative affect reduction fits within existing negative reinforcement frameworks for the maintenance of cigarette smoking and extends this framework to a specific high risk group in the context of a high risk situation. Incorporating NA regulatory strategies for socially stressful situations may help to both prevent smoking initiation and improve cessation rates among individuals with SP or elevated SP symptoms.

Table i. Schedule of Administration of Measures

	Screen	**Neutral Session**					**Social Stress Session**				
Measure		Cig 1	Post Cig 1	After Video	Cig 2	Post Cig 2	Cig 1	Post Cig 1	After Video	Cig 2	Post Cig 2
NCI Smoking History and Current Status Indices			x*					x*			
mFTQ			x*					x*			
TLFB			x					x			
SIAS	x										
PANAS			x	x		x		x	x		x
Topography		x			x		x			x	

*Note: The mFTQ and NCI Smoking History measures were counterbalanced across sessions

*Note: The mFTQ and NCI Smoking History measures were counterbalanced across sessions

Table ii. Sample demographics

	Full Sample (*n*=73)	**High SP (*n*=31)**	**Average SP (*n*=42)**
Age *M(SD)*	19.75(1.18)	19.94(1.21)	19.61(1.16)
Gender (% female)	41.7%	45.2%	39.0%
Racial/ethnic background			
White	73.6%	71.0%	75.6%
Black or African American	6.9%	9.7%	4.9%
Asian or Asian American	15.3%	12.9%	17.1%
Hispanic or Latino	2.8%	3.2%	2.4%
Other	1.8%	3.2%	0%
Cigarettes per smoking day *M(SD)**	7.43(4.72)	8.95(5.39)	6.28(3.83)

* $p < .05$

Table iii. Number of participants who chose to smoke each cigarette

	Neutral Session (*n*=72)		**Stress Session (*n*=72)**	
	First Cigarette	Second Cigarette	First Cigarette	Second Cigarette
Participants Smoked	72	66	72	69
Participants did not Smoke	0	6	0	3

Table iv. Smoking topography data

	Full Sample (*n*=73)	**High SP (*n*=31)**	**Average SP (*n*=42)**
Neutral Session			
Cigarette 1 *M(SD)*	*n* = 69	*n* = 30	*n* = 39
Number of puffs	16.29(5.77)	16.67(5.25)	16.00(6.19)
Puff volume (ml)	46.05(22.04)	45.22(23.86)	46.68(20.83)
Total puff volume (ml)	699.45(340.09)	734.43(421.28)	672.54(264.23)
Interpuff Interval (s)	13.76(5.66)	12.86(5.68)	14.44(5.61)
Cigarette 2 *M(SD)*	*n* = 63	*n* = 30	*n* = 33
Number of puffs	15.94(6.12)	16.57(5.91)	15.36(6.34)
Puff volume (ml)	42.21(19.03)	41.86(21.66)	42.53(16.62)
Total puff volume (ml)	642.73(334.12)	689.59(425.77)	600.13(219.26)
Interpuff Interval (s)	14.41(8.32)	13.60(6.61)	15.15(9.67)
Stress Session			
Cigarette 1 *M(SD)*	*n* = 66	*n* = 28	*n* = 38
Number of puffs	15.89(5.65)	15.57(5.78)	16.13(5.62)
Puff volume (ml)	46.75(29.98)	39.82(13.18)	51.86(37.28)
Total puff volume (ml)	748.23(697.29)	632.99(332.16)	833.15(869.59)
Interpuff Interval (s)	14.38(6.68)	13.79(6.08)	14.81(7.14)
Cigarette 2 *M(SD)*	*n* = 60	*n* = 26	*n* = 34
Number of puffs	15.22(5.24)	15.65(5.81)	14.88(4.82)
Puff volume (ml)	45.86(29.67)	46.77(40.95)	45.17(17.40)
Total puff volume (ml)	652.46(337.46)	668.65(415.63)	640.08(269.01)
Interpuff Interval (s)	14.71(7.04)	13.97(6.53)	15.27(7.45)

Table v. Positive and negative affect data

	Full Sample (*n*=73)	**High SP (*n*=31)**	**Average SP (*n*=42)**
Neutral Session			
Post Cigarette 1 *M(SD)*			
Positive Affect	26.24(7.62)	25.17(6.51)	27.02(8.33)
Negative Affect	14.27(4.99)	14.83(3.92)	13.85(5.65)
Pre Cigarette 2 *M(SD)*			
Positive Affect	24.67(8.07)	24.20(7.24)	25.02(8.70)
Negative Affect	12.11(3.81)	11.97(2.43)	12.22(4.59)
Post Cigarette 2 *M(SD)*			
Positive Affect	24.97(8.90)	24.00(9.44)	25.71(8.51)
Negative Affect	12.51(3.38)	12.90(2.41)	12.22(3.96)
Stress Session			
Post Cigarette 1 *M(SD)*			
Positive Affect	25.77(6.86)	24.58(6.26)	26.63(7.22)
Negative Affect	14.55(5.46)	15.40(5.20)	13.93(5.62)
Pre Cigarette 2 *M(SD)*			
Positive Affect	26.34(8.49)	23.07(7.98)	28.73(8.13)
Negative Affect	19.25(7.16)	22.60(8.16)	16.80(5.19)
Post Cigarette 2 *M(SD)*			
Positive Affect	26.62(8.95)	23.77(8.20)	28.71(9.00)
Negative Affect	16.45(5.78)	18.20(6.46)	15.17(4.91)

Note. Post cigarette 1: Affect ratings following smoking the first cigarette at each session. Pre cigarette 2: Affect ratings following being administered the Trier variant or watching the neutral video. Post cigarette 2: Affect ratings following smoking the second cigarette at each session.

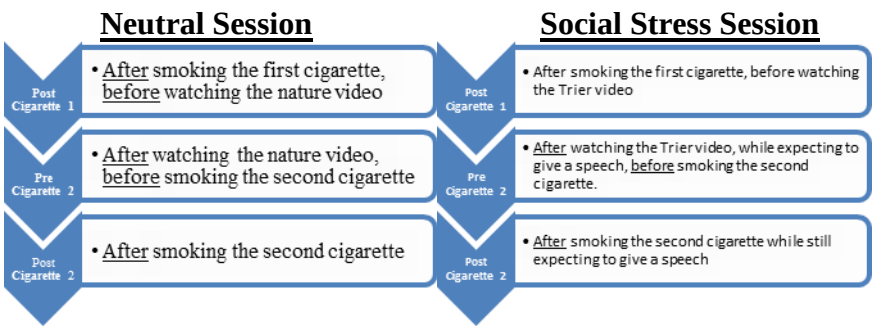

Figure i: Time points for subsequent analyses

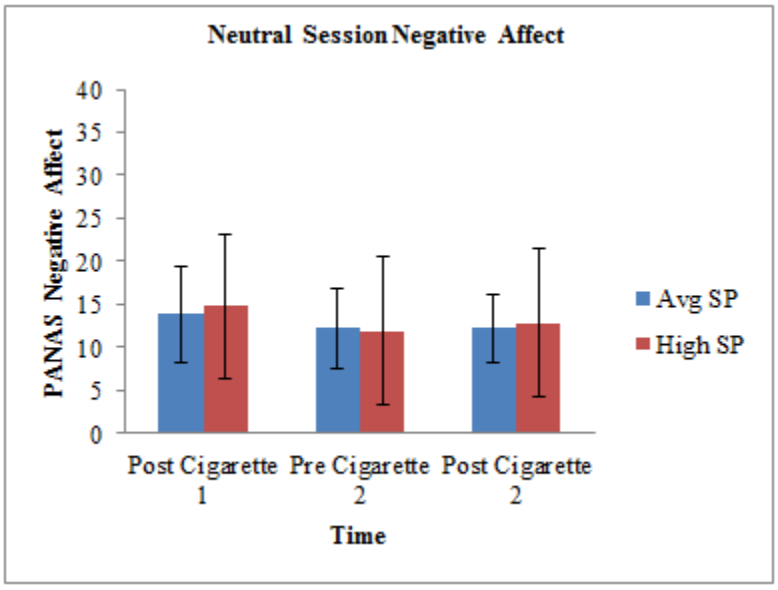

Figure ii: The relationship between SP group and NA during the neutral session.

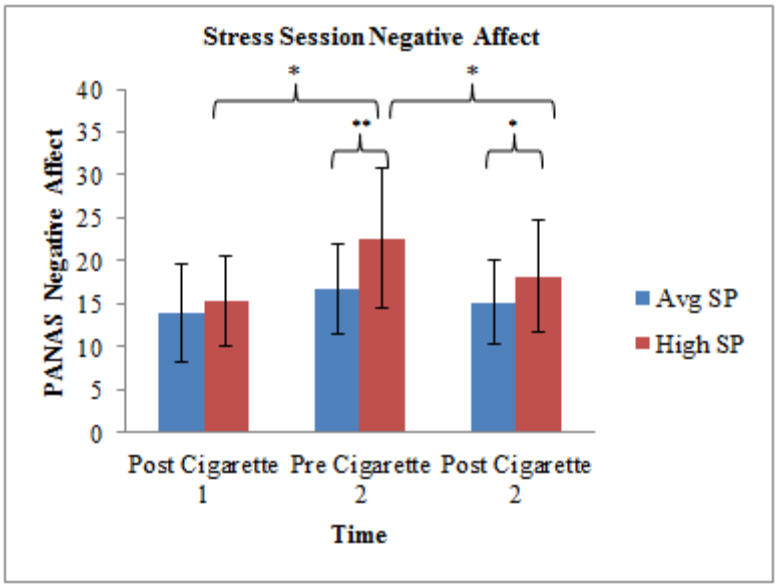

Figure iii: The relationship between SP group and NA during the social stress session. There were significant between-subjects effects of SP group on NA such that High SP individuals were significantly higher in NA at pre cigarette 2 and post cigarette 2. There were also significant within-subjects effects such that High SP significantly increased in NA in anticipation of the social stressor and significantly decreased in NA following smoking the second cigarette. *Note: *p*<.05, ***p*<.01

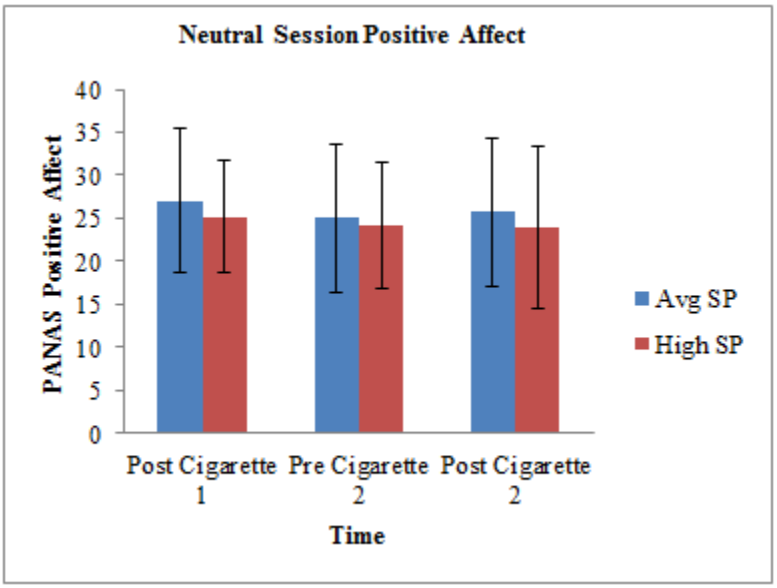

Figure iv: The relationship between SP group and PA during the neutral session.

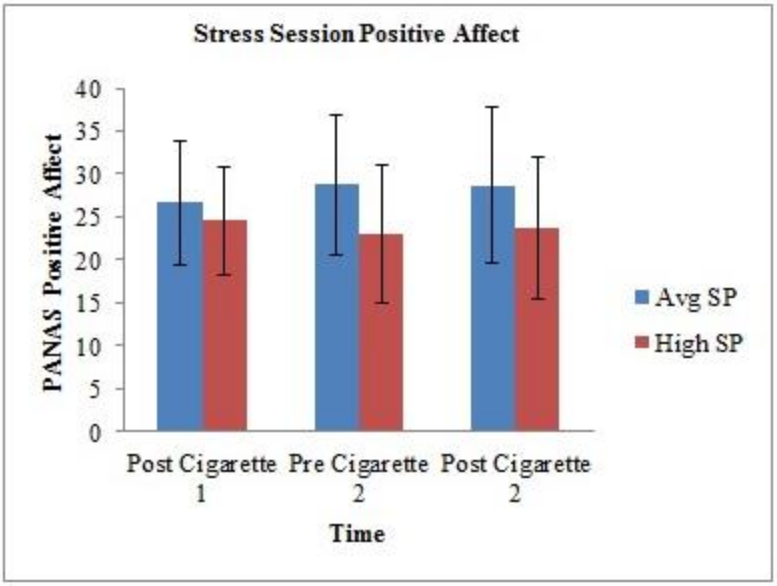

Figure v: The relationship between SP group and PA during the stress session.

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