Stability of Emotional Response in Adolescent Smokers and Nonsmokers: A Longitudinal Analysis

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THESIS

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LIST OF ABBREVIATIONS

ANCOVA	Analysis of covariance
ANOVA	Analysis of variance
B	Unstandardized beta
CO	Carbon monoxide
CReSS	Clinical Research Support System
dB	Decibels
EMG	Electromyography
F	F-value
HR	Heart rate
IAPS	International Affective Picture System
ITI	Inter-trial interval
ms	Milliseconds
mFTQ	Modified Fagerstrom Tolerance Questionnaire
ns	Nonsignificant
n	Number subgroup
p	P-value
s	Seconds
SC	Skin conductance
SD	Standard deviation
SER	Startle eyeblink response
t	T-score
z	Standardized score

SUMMARY

Despite the high prevalence of cigarette smoking among adolescents, we have yet to fully understand the relationship between the development of nicotine dependence and emotion regulation over time. Extant literature indicates that, like adults, adolescents initially smoke to relieve stress and negative affect. It remains unclear, however, whether smoking is effective in reducing negative emotion among newer smokers, both in the short- and long-term. The overall goal of the present study, then, was to determine whether the affective benefits derived from smoking change over time in adolescent smokers and whether the development of nicotine dependence might relate to these changes. For smokers, we anticipated that emotional response would increase across visits, though the affective pattern would remain stable. Further, we hypothesized that change in nicotine dependence would moderate emotional response over time such that those with increased nicotine dependence would experience less affective benefit from a single cigarette over time, and therefore, exhibit greater emotional response at Visit 3. In contrast to this hypothesized temporal pattern for smokers, we anticipated that emotional response would decrease over time for neversmokers, though the affective pattern would remain stable. We also hypothesized that emotional response would be reliable across sessions, such that emotional response at the matched session would predict similar responses at Visit 3. Findings were mixed: while there were expected results in terms of affective patterns in startle eyeblink response (SER), skin conductance (SC), and heart rate (HR), emotional response over time was less reliable. For both smokers and neversmokers, SER latency, or speed, was greater at the first session than the second, which indicates less response to affective images over time and contradicts findings from

all other measures, though this might be due to its relative unreliability. Further, change in nicotine dependence predicted average SC level and moderated emotional response over time as indexed by average HR only. Still, we were able to confirm previous research in both adolescents and adults regarding affective patterns in psychophysiological measures while continuing to ask questions about the association between the development of nicotine dependence and emotional response over time. This relationship remains unclear and in need of further research, as it seems an important piece of the theoretical puzzle surrounding escalation to continued and chronic cigarette smoking.

I. INTRODUCTION

Smoking is a problem behavior most often initiated in adolescence, with 20% of eighth graders reporting some experience with cigarettes; indeed, over the last 30 years, cigarettes have remained the substance most often used on a daily basis by high school students (Johnston, O'Malley, Bachman, & Schulenberg, 2009). Despite our knowledge of the epidemiology of this behavior, we have yet to fully understand the concurrent development of continued smoking behavior and nicotine dependence. In adults, motivation to smoke often involves an affect regulation component, as smokers seek to alleviate the negative affect associated with nicotine withdrawal (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004). Emerging research indicates that this might be true of young, light smokers as well (Kassel et al., 2007). Understanding the relationship between the development of nicotine dependence and emotion regulation is of great importance to future prevention and intervention efforts within this population. Prior research describes a dramatic increase in substance use disorders during this same time period (i.e., adolescence; Costello, Mustillo, Erkanli, Keeler, & Angold, 2003), and although some research has indicated that smokers can become dependent earlier than originally thought (DiFranza, 2008), few studies have followed adolescents to investigate the possible link between emerging nicotine dependence and affect regulation over time.

A. Smoking Onset and Emotion Regulation

Extant literature indicates that, like many adult smokers, a significant proportion of adolescents smoke to relieve stress and negative affect (Kassel, Stroud, & Paronis, 2003; Koval & Pederson, 1999; Siqueira, Diab, Bodian, & Rolnitzsky, 2000).

Longitudinal studies of adolescents have shown that those who become smokers perceive more stress in their lives and do not utilize coping strategies effectively, perhaps making them more likely to view smoking as a viable coping resource (Dugan, Lloyd, & Lucas, 1999). Further, those who escalate from experimenting with smoking to regular use generally have more positive physiological and psychological experiences during their first few smoking episodes than those who fail to escalate (cf. Eissenberg & Balster, 2000; Friedman, Lichtenstein, & Biglan, 1985).

Piasecki and Baker (2000) speculate that perhaps smoking replaces severe, unexpected periods of negative affect with smaller, more predictable episodes. Indeed, some have described smoking as part of a vicious cycle (Parrott, 1999), whereby stress and negative affect precipitate smoking, and eventually, consistent smoking behavior results in nicotine dependence. The nature of nicotine dependence dictates that there will be some manifestation of physiological and/or psychological withdrawal after abstinence (even of brief duration), and that the smoker will smoke again to alleviate these symptoms, thus perpetuating the cycle. Baker and colleagues (2004) illustrate a similar model of addiction in which withdrawal-based learning results in sensitivity to the interoceptive cues of negative affect, leading to further substance use.

In a three-year study of adolescents, however, Wills, Sandy, and Yaegar (2002) found a unidirectional relationship between negative affect and smoking, such that negative affect precipitated smoking behavior and not that smoking "caused" stress. Further, whereas nicotine withdrawal does increase self-reported negative affect, it does not appear to affect involuntary emotional regulation, as indexed by the startle eyeblink response (SER) (Piper & Curtin, 2006). Though it has become increasingly clear that

young smokers might share motives for smoking with their adult counterparts, perhaps partially informed by parental use (Nichter, Nichter, Vuckovic, Quintero, & Ritenbaugh, 1997), it remains unclear whether smoking actually reduces subjective stress and negative affect among newer smokers (Kassel et al., 2003).

Piper and Curtin's (2006) compelling work demonstrates a possible disconnect between subjective and objective (e.g., psychophysiological) emotional response that limits the interpretation of self-report when assessing the affective consequences of both acute smoking (nicotine) effects and nicotine withdrawal. Indeed, self-report is the most common form of assessment, despite its reliance on self-awareness and a lack of bias, which is sometimes associated with describing one's own affective experience. Correspondingly, employment of a multidimensional approach to the evaluation of emotional response in drug research (e.g., Stritzke, Patrick, & Lang, 1995), i.e., one that draws upon psychophysiological indices of affect, offers clear advantages with respect to enhancing the internal validity and reliability of these findings. A multimodal approach that addresses smoking/affect relationships with SER, skin conductance (SC), and heart rate (HR) as psychophysiological measures of emotional response would benefit the literature.

B. Startle Eyeblink Response

The SER is a physiological indicator of affective state that has proven sensitive to both visual and auditory stimuli (Bradley, Cuthbert, & Lang, 1990; Vrana, Spence, & Lang, 1988). The startle response in general first received interest in the 1930s, when Landis and Hunt (1939) observed a full-body reaction to a pistol shot. The fastest and most reliable element of this response was the sudden closure of the eyelids, and further

research showed that this action remained even when a stimulus failed to engage the full-body startle response.

The SER is a result of the contraction of the orbicularis oculi muscle below the eye and occurs roughly 30-50ms after the onset of an auditory stimulus. Generally, the magnitude (strength) and latency (speed) of the response are of greatest interest in the study of emotion, as different patterns emerge depending on the affective state of the individual (Lang, Bradley, & Cuthbert, 1990). Perhaps the most salient of these is the fear-potentiated SER, a term coined by Davis and associates (see Davis, Hitchcock, & Rosen, 1987 for review), which was first elicited in classical conditioning studies. Early research using rats found that startle probes presented in the context of affective stimuli (in this case, a light and buzzer that had previously been associated with a toy pistol shot) evoked a larger full-body reaction, and therefore a larger SER, than control stimuli (Brown, Kalish, & Farber, 1951). Lang and colleagues (1990) subsequently hypothesized that SER would vary similarly as a function of affective valence and arousal level. In this case, valence refers to the likelihood of assuming either an appetitive (approach) or defensive (avoidance) behavioral stance, whereas arousal refers to general energy level.

In accordance with this theory, perhaps the most salient pattern to emerge is the impact of negative affect on SER. Masterson and Crawford (1982) organized negatively valenced animal behaviors into a "defense motivation system," arguing that such behaviors comprise a set of natural defensive reactions. Accordingly, whole-body startle has been shown to vary as a function of affective state in rodents (Davis & Astrachan, 1978; Greenwald, Bradley, Cuthbert, & Lang, 1998; Grillon & Davis, 1997; Hamm, Greenwald, Bradley, & Lang, 1993; Schmid, Koch, & Schnitzler, 1995). This response

mirrors SER in humans, and so might originate from the same type of defensive system. Therefore, one might predict that SER would be greater among those experiencing negative affect, which is associated with both fear and the desire to defend oneself. Researchers often induce such affect by presenting participants with a series of images that vary in emotional content, i.e., depict positive, negative, and neutral events, objects, or people. The SER has been shown to increase significantly from neutral to negative images (Bradley, Cuthbert, & Lang, 1988; Cook, Hawk, Davis, & Stevenson, 1991; Lang, Davis, & Öhman, 2001; Vrana et al., 1988), and this effect is even more pronounced when combined with increased general arousal (Lang, 1995). The SER also increases significantly from positive to neutral images, suggesting that decreased magnitude is characteristic of positive affect (Bradley et al., 1988; Vrana et al. 1988), with this effect also increasing with general arousal level (Lang, 1995). Responses in children and adolescents generally conform to these patterns as well (McManis, Bradley, Berg, Cuthbert, & Lang, 2001).

C. Skin Conductance and Heart Rate

The SER is but one part of a "behavioral cascade" that results from exposure to an aversive stimulus (Lang et al., 2001). SC is a measure of electrodermal (i.e., sweat gland) response that, along with HR, taps into the autonomic nervous system. This physiological system is responsible for modulating peripheral functions (Öhman, Hamm, & Hugdahl, 2000). It consists of the sympathetic (activation) and parasympathetic (relaxation) branches (Mauss & Robinson, 2009). Whereas SC is under sympathetic control, HR is under parasympathetic control and therefore decreases to facilitate vigilance against threats to the organism (Lang & Bradley, 2010). The eye is the primary

pathway into the brain for mammals, and so, images and text are particularly evocative of this defensive response (Lang & Bradley, 2010). As SER is potentiated, SC increases with arousal, and HR decelerates before accelerating to prepare for action (Lang et al., 2001).

Whereas specific patterns of SER characterize exposure to differently-valenced stimuli, SC and HR are thought to provide near-direct measures of general physiological arousal (Lang et al., 1990). SC appears to be least influenced by valence, as it increases monotonically with arousal level (Lang, Bradley, & Cuthbert, 1998), although some studies suggest that SC changes most when one is viewing negative images, as compared with neutral or positive images (McManis et al., 2001). Heart rate, however, might be able to distinguish among different emotions (Ekman, Levenson, & Friesen, 1983; Levenson, 1992). For example, previous studies have shown that heart rate decelerates when viewing unpleasant pictures and accelerates when viewing pleasant pictures (Lang et al., 1998), though it also accelerates when processing fearful text, as compared with neutral text (Vrana, Cuthbert, & Lang, 1989).

D. Emotional Response Over Time

Over time, however, these physiological responses lessen with repeated exposure to visual or auditory stimuli, a phenomenon known as habituation. Previous research has indicated that this pattern is normative in healthy participants within a single session (Bradley, Lang, & Cuthbert, 1993), and also across multiple sessions within the same day (i.e., 3 separate sessions within 8 hours; Abel, Waikar, Pedro, Hemsley, & Geyer, 1998). Differences among affective categories persist, however, even as overall levels of response decline.

To date, few studies have examined emotional response over multiple days, as indexed by either subjective or physiological measures, in any population. Larson and colleagues (2000) recruited 71 undergraduate students to participate in two experimental sessions, separated by four weeks. Half of the sample was randomized to view the same slides at each visit, whereas the other half was presented with new slides during the second session. Analyses examined the correlation between emotion modulation of SER at the first and second sessions. The results indicated that emotional response at the first session was more highly correlated with response at the second among those who viewed two different sets of pictures, as compared with those who viewed the same slides at both timepoints.

These findings inform the current study, as they demonstrate the stability of emotional response over time. Ultimately, however, Larson and colleagues (2000) focused on issues of methodology rather than factors that might impact such differential affective states. Anecdotal and research-based evidence suggest that smoking might be an important modulator of emotional response. Most salient for smokers is the connection between self-administration of nicotine, the primary psychoactive ingredient in cigarettes, and its purported ability to help regulate emotional response. Though the acute effects of nicotine have been widely studied, conflicting results have failed to paint a clear picture of its effects on emotion.

E. Acute Effects of Nicotine in Smokers

The competing subjective and objective effects of nicotine create a paradox that persists over decades of smoking research. Nicotine increases heart rate, perhaps even more in adolescents than adults (Corrigall, Zack , Eissenberg, Belstio, & Scher, 2001),

but decreases emotional response as indicated by SER (Cinciripini et al., 2006), SC response magnitude (Gilbert & Hagen, 1980), and tolerance of electric shock (Nesbitt, 1973), though the latter findings have been questioned (Shiffman & Jarvik, 1984). Previous studies have shown that smoking increases subjective feelings of head rush and decreases both positive (Perkins, Jetton, & Keenan, 2003) and negative affect (Gilbert et al., 2008). Despite these mixed results, however, most smokers over the last few decades have claimed that smoking relaxes them (Frith, 1971; Ikard, Green, & Horn, 1969; Ikard & Tompkins, 1973). Subjective measures have indicated that recency of smoking is inversely associated with negative affect, with smoking successfully reducing this level of negative emotion (Kassel et al., 2007). This effect has been shown in measures of psychophysiological response as well, with SER decreasing and HR increasing in nicotine-deprived adult smokers after they smoke a single cigarette (Mueller, Mucha, & Pauli, 1998). Further, greater negative affect in abstinent smokers has been indicated by increased SER, as compared with nonsmokers (Grillon, Avenevoli, Daurignac, & Merikangas, 2007).

Summary

We still have yet to fully understand the relationship between the development of nicotine dependence and emotion regulation over time. Extant literature indicates that, like adults, adolescents initially smoke to relieve stress and negative affect. It remains unclear, however, whether smoking is effective in reducing negative emotion among newer smokers, especially given the interpretation problems inherent with self-report measures and the overall dearth of research examining real-time associations between smoking and affect. Previous research has identified SER has as an alternative indicator

of emotional response, with distinct patterns associated with differentially-valenced stimuli. Further, SC and HR provide options for indexing general arousal. Whereas all physiological measures are subject to habituation in the short-term, no one has examined differences in emotional response over time, especially as they might relate to problem behaviors. Smoking is often used as a strategy for coping with negative affect, and smokers generally report a reduction of negative emotion after smoking. Accordingly, SER decreases significantly in nicotine-deprived adult smokers after they smoke a single cigarette, whereas HR increases (Mueller et al., 1998). Findings from our own lab indicate that smoking a single cigarette also reduces negative affect in adolescents, as indicated by increased latency of the SER and reduced SC (Kassel et al., In press, 2011). Due to a dearth of longitudinal studies, however, it is unclear whether smoking effectively reduces negative affect in the long-term, or whether the actual development of nicotine dependence relates to smoking's acute effects on emotional response.

F. Aims of the Current Study

The goal of the current study, then, was to determine whether the affective benefits derived from smoking change over time in adolescent smokers, and whether the development of nicotine dependence might relate to these changes. More specifically, the emotional response of smokers at either baseline or 6-10 weeks post-baseline was compared with their emotional response at 15 months post-baseline, with change in nicotine dependence serving as a potential moderator of emergent patterns while controlling for smoking frequency, quantity, and recency. Emotional response in nonsmokers was examined as well, to provide a comparison group for their smoker counterparts. For smokers, we anticipated that emotional response would increase across

visits, as indicated by greater SER magnitude, SER amplitude, and SC and lower SER latency and HR over time. Further, we hypothesized that the affective pattern would remain stable: average SC level, SER magnitude, and SER amplitude would be largest in response to negative slides at each visit whereas HR and SER latency would be lowest in response to negative slides (see Figures 1a-1c for predicted results). Finally, we anticipated that changes in emotional response over time would be moderated by concurrent change in nicotine dependence. For neversmokers, we anticipated that emotional response would decrease over time as indicated by lower SER magnitude, amplitude, and SC and greater SER latency and HR over time, though the affective pattern would remain stable. We also hypothesized that emotional response at Visit 1 or Visit 2 would predict emotional response at Visit 3.

II. METHOD

A. Participants

1. Program project.

The current study draws from a cohort of adolescents recruited as part of a larger program project, which examined the social and emotional contexts of smoking using various methodologies (i.e., ecological momentary assessment, lab-based measures, and observational coding). A group of 1263 adolescents from the Chicagoland area enrolled in the project during their first and second years of high school and continued to participate over the next four years.

Participants from 16 area high schools were recruited via survey, which gathered information about smoking behavior, intentions, demographics, and parental smoking status. Based on their responses to this screening questionnaire, eligible students and their parents were invited to participate in the longitudinal study. Participation in the longitudinal study required students and their parents to agree to complete follow-up assessments. They were also informed that they might be invited to participate in additional projects (i.e., the individual studies under the larger program project).

2. Project 3.

A subgroup of 217 adolescents participated in Project 3, "Smoking's Effect on Emotion in Adolescent Smokers." The goals of this lab-based study were to determine whether 1) adolescent smokers derive affective benefit from smoking a cigarette, 2) smoking deprivation results in nicotine withdrawal symptoms, and 3) individual differences in smoking's effect on emotional response and withdrawal reduction are predictive of subsequent developmental smoking behavior and patterns. Potential

participants who reported smoking at least one cigarette in the last two weeks without a desire to quit qualified as "smokers," as compared with "neversmokers," who had never smoked. All participants and legal guardians provided informed assent and consent, respectively, prior to participation (see Appendix A).

B. Self-Report Measures

1. Modified Fagerstrom Tolerance Questionnaire.

To assess nicotine dependence, participants completed the seven-item version of the Fagerstrom Tolerance Questionnaire, modified for use with adolescent smokers (mFTQ; Prokhorov, Koehly, Pallonen, & Hudmon, 1998; Prokhorov, Pallonen, Fava, Ding, & Niaura, 1996), at both their baseline visit and 15 month follow-up as part of a battery given by the larger program project. The mFTQ was designed to correlate with physiological measures of dependence, containing items that assess smoking rate, smoking soon after waking, smoking even when ill, difficulty refraining from smoking, smoking more heavily in the morning than other times of the day, reporting the first cigarette of the day as the most difficult to give up, and frequency of inhalation. The current study included continuous response choices for all mFTQ items except for the morning smoking item (scored as yes/no), with scoring rescaled to compare to the original FTQ (Prokhorov et al., 1996). Summing all items created a total score, and the measure demonstrated adequate internal consistency with the current sample (coefficient alpha = 0.66). In adult populations, an overall score of 6 or more represents a high level of nicotine dependence (Prokhorov et al., 1996; see Appendix B for individual items).

2.Smoking behavior.

At each Project 3 session, participants completed a questionnaire about their current smoking behavior (see Appendix C for individual items). Of interest in the current study are the number of days they smoked out of the past 30 days (frequency), the average number of cigarettes smoked on those days (quantity), and the last time they smoked a cigarette before coming into the lab (recency).

C. Physiological Measures

1. Emotional stimuli and the startle eyeblink response.

Emotional stimuli were presented as a series of 36 slides from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1997). The IAPS slides were developed to provide a set of normative emotional stimuli as a tool for investigating emotion (Lang, Öhman, & Vaitl, 1988). These images have been previously rated and normed on dimensions of valence and arousal (Lang, Bradley, & Cuthbert, 1997). Within the current study, positive slides included scenes of food, children, and animals; negative stimuli included scenes of aimed guns and threatening animals; and neutral slides included pictures of household objects, plants, and neutral faces. Positive and negative slides were chosen to be equal in rated arousal, both of which were higher in arousal than neutral slides. No slides containing nudity or scenes of death were shown to ensure that images were age-appropriate.

During the slide presentation, the SER was elicited by presenting white noise bursts (95dB for 50ms) via Telephonics headphones (Telephonics, Farmingdale, NY). On eight of the trials for each slide type, the acoustic startle probe stimulus occurred at a variable point during the 6s slide viewing period (3, 4, or 5s after slide onset; see Stritzke et al., 1995). One of the four slides within each content block was presented without a

startle stimulus. In addition, each block included three startle stimuli that were presented during the intervals between slide presentations. These random interslide aural stimuli served to reduce the temporal predictability of the startle and to de-emphasize a specific association between slide viewing and startle stimuli (see Vrana et al., 1988). They also provided an additional measure of response during the inter-trial interval (ITI). Unilateral measurement of the eyeblink component of the SER was done by recording electromyography (EMG) activity from the orbicularis oculi muscle beneath the left eye. The raw EMG signal at each site was amplified and frequencies below 90 Hz and above 250 Hz were filtered via a BIOPAC bioamplifier (BIOPAC Systems, Inc., Goleta, CA). Data were then recorded and displayed using BIOPAC Systems' AcqKnowledge data acquisition software (Version 4.0) installed on a Pentium IV computer, with a resolution of 1000 Hz.

2. Skin conductance level.

SC was assessed continuously throughout the presentation of the IAPS slides. Electrodes were filled with lubricating jelly and positioned on the hypothenar eminence of the nondominant hand. These electrodes were then connected to a BIOPAC isolated SC coupler that provided a constant voltage of 0.5 V. SC level was averaged across the 6s slide-viewing period. A change score was also computed to measure the mean change in SC from the 1s baseline immediately preceding the onset of each slide.

3. Heart rate.

HR was recorded by electrodes placed on the right and left inner forearms using a Schmitt trigger that interrupted the computer each time it detected the cardiac R-wave, providing a record of interbeat intervals to the nearest millisecond. HR response was

averaged across the 6s slide-viewing period. A change score was also computed to measure the mean change in HR from the 1s baseline immediately preceding the onset of each slide.

D. Procedure

All participants in Project 3 completed three experimental sessions: baseline (Visit 1), 6-10 weeks after baseline (Visit 2), and 15 months after baseline (Visit 3). Each session was identical, with the exception of smokers being offered the chance to smoke a cigarette at either Visit 1 or Visit 2 and again at Visit 3. Neversmokers were not offered this opportunity at any of the three visits (see Figure 2 for the session timeline).

Upon arrival in the lab, all participants provided an expired breath carbon monoxide (CO) reading (Vitalograph EC 50 CO monitor, Vitalograph, Lenexa, KS) and completed various self-report questionnaires. Once they finished these surveys, they were fitted with electrodes to measure SER, SC, and HR and completed a baseline psychophysiological measurement period. Smokers were then offered the chance to smoke as much or as little of a cigarette as they wanted, choosing from among eight popular brands, half of which were mentholated. Those who chose not to smoke and neversmokers were offered a magazine and asked to sit and relax for seven minutes. Smokers who chose to smoke completed the following steps during the same time period.

1. Cigarette administration.

Before smoking, participants provided another CO reading and received a cigarette and specific instructions. They were asked to light the cigarette before placing it in a CReSS device, which examines many different aspects of smoking topography, including both volume and duration of each puff (Clinical Research Support System

Smoking Topography Machine, Plowshare, Baltimore, MD). They were told to smoke normally (i.e., ad libitum, as much or as little of the cigarette as they desired) and remove the cigarette butt when finished. Participants then provided another CO reading, immediately after smoking the cigarette.

2. Slide presentation and ratings.

Following the smoking (for smokers who smoked) or relaxation (for smokers who did not smoke and neversmokers) period, all participants completed a second psychophysiological assessment (i.e., SER, SC, and HR) and self-report questionnaires. At this time, the IAPS slide presentation began, with psychophysiological assessment throughout, as described above. Following this presentation, all participants completed a third set of self-report questionnaires. They were then asked to view the IAPS slides a second time to rate each on scales of valence (happy vs. unhappy) and arousal (aroused vs. calm), though these slide ratings are not discussed in this paper.

After providing these ratings, smokers completed an end of study questionnaire that asked why they had (or had not) chosen to smoke during the session. Those who smoked were also asked to rate the harshness, strength, and pleasantness of the cigarette they received. At the end of the session, all participants were debriefed.

E. Data Management

1. Startle eyeblink response.

Responses to individual slides were averaged for each affective category (i.e., positive, neutral, and negative) to yield a single value for magnitude, or strength of SER, and another for latency, or speed of SER. Amplitude was also derived from magnitude

for each affective category by excluding trials for which there was no SER (Blumenthal et al., 2005).

As SER has been shown to increase significantly from neutral to negative slides, change scores were also calculated to examine how negative stimuli potentiated SER, i.e., increased it above response to neutral stimuli. The negative-neutral score was calculated by subtracting magnitude, amplitude, and latency in response to neutral slides from those for negative slides, respectively. The negative-ITI score was similarly calculated by subtracting magnitude, amplitude, and latency in response to the aural stimuli presented between slide presentations from those for negative slides, respectively.

2. Skin conductance and heart rate.

Similar to data treatment for SER, SC and HR responses to individual slides were averaged for each affective category, yielding separate average and difference (from pre-slide baseline) scores for positive, neutral, and negative slides.

3. Summary of dependent variables.

Each affective category (i.e., positive, neutral, and negative) yielded the following variables, as described above: SER magnitude, SER amplitude, SER latency, average SC level, SC level change, average HR, and HR change. In addition, a change score captured the difference between SER magnitude, amplitude, and latency to negative versus neutral slides. A second change score compared SER magnitude, amplitude, and latency to negative slides with the response to an auditory stimulus presented between slides. All variables underwent natural log transformation to reduce skewness and kurtosis.

F. Data Analysis

1. Participants.

Of interest in the current study is how the development of nicotine dependence and/or smoking behavior might relate to the stability (or instability) of emotional response in adolescent smokers over time. Therefore, analyses involving smokers focused on sessions during which they chose to smoke. Of the 122 smokers enrolled in the study, 64 smoked at either Visit 1 or Visit 2 (hereafter, referred to as the initial smoking session) and Visit 3, and so are included in this set of analyses. Basic smoking-related variables at the initial smoking session and Visit 3 (i.e., frequency, quantity, and recency of smoking) were compared using Wilcoxon Signed Rank Tests. Nicotine dependence at the initial smoking session and Visit 3, as measured by the mFTQ, was examined using a Student's t-test. As compared with smokers, neversmokers (n=36) served as a control group. They were proportionally matched to smokers on gender and the visits included in subsequent analyses were chosen to match those of their smoker counterparts (i.e., Visit 1 or Visit 2, hereafter referred to as the matched session, and Visit 3).

2. Smokers.

For smokers, the first set of analyses examined patterns in affective response across multiple sessions using a series of 2 (session) x 3 (affective category) within-subjects analyses of variance (ANOVAs). A set of analyses of covariance (ANCOVAs) included change in nicotine dependence as a covariate, as determined by subtracting mFTQ scores at Visit 1 from scores at Visit 3.

In a third set of analyses, emotional response at Visit 3, as indexed by SER, SC, and HR measures, was regressed onto emotional response at the initial smoking session.

These analyses were done separately for each dependent variable and affective category. Change in nicotine dependence, as defined above, was entered as a potential moderator after centering all values, as recommended by Aiken and West (1991). Significant interactions were followed up using simple slopes analyses. As described earlier, we anticipated that change in nicotine dependence would moderate emotional response, such that emotional response would increase more in those who developed greater nicotine dependence over time.

3. Neversmokers.

For neversmokers, the first set of analyses examined patterns in affective response across multiple sessions with a series of 2 (session) x 3 (affective category) within-subjects ANOVAs. A second set of analyses regressed emotional response at Visit 3, as indexed by SER, SC, and HR measures, onto emotional response at the matched session. These analyses were done separately for each affective category.

III. RESULTS

A. Participant Characteristics

Table 1 illustrates general characteristics for both smokers and neversmokers. There were no significant differences in basic demographics, though there were more males in the smoker group than the neversmoker group. Participants were between 15 and 16 years old, and most were Caucasian and non-Hispanic/Latino. At baseline, most smokers reported smoking one-third to all the days in a month, an average of two to three cigarettes per day, and within 24 hours of completing their first session. Both frequency and quantity of smoking had significantly increased by the third session, with most smokers smoking all the days in a month and six to 10 cigarettes per day, $z(63) \geq -2.674$,

*p*s < 0.01. Further, while it was most common for smokers to have their last cigarette within 24 hours of both sessions, this majority significantly increased over time, $z(63) = -2.639$, $p < 0.01$. Finally, nicotine dependence, as assessed by the mFTQ at Visit 1 and Visit 3, significantly increased over time, $t(63) = -3.233$, $p < 0.01$.

B. Smokers

1. Emotional response over time.

a. *Startle eyeblink response.*

For SER magnitude, a two-way ANOVA revealed a main effect of time, $F(1, 54) = 16.284$, $p < 0.001$, such that SER magnitude was greater at the initial smoking session than at Visit 3. This initial analysis also showed a main effect of affective category, $F(2, 53) = 11.584$, $p < 0.001$. As hypothesized, SER magnitude was smaller in response to positive than negative slides, $F(1, 54) = 23.237$, $p < .001$, and greater in response to negative than neutral slides, $F(1, 54) = 14.259$, $p < 0.001$ (Figure 3a).

For SER amplitude, a two-way ANOVA revealed a main effect of time, $F(1, 54) = 5.268$, $p < 0.05$, such that SER amplitude was greater at the initial smoking session than at Visit 3. This initial analysis also showed a main effect of affective category, $F(2, 53) = 5.615$, $p < 0.01$. As hypothesized, SER amplitude was smaller in response to positive than negative slides, $F(1, 54) = 6.396$, $p < 0.05$, and greater in response to negative than neutral slides, $F(1, 54) = 4.731$, $p < 0.05$ (Figure 3b).

For SER latency, a two-way ANOVA revealed a main effect of time, $F(1, 54) = 10.434$, $p < 0.01$, such that SER latency was greater at the initial smoking session than at Visit 3. This initial analysis also showed a trend for affective category, $F(2, 53) = 2.782$,

$p = 0.07$, such that, unexpectedly, SER latency was smaller in response to positive than negative slides, $F(1, 54) = 5.918$, $p < 0.05$ (Figure 3c).

b. *Skin conductance level.*

For average SC level, a two-way ANOVA revealed no main effect of time, $F(1, 54) = 2.239$, p = ns, or affective category, $F(2, 53) = 0.398$, p = ns.

For SC level change, a two-way ANOVA revealed no main effect of time, $F(1, 54) = 2.393$, p = ns, or affective category, $F(2, 53) = 0.909$, p = ns.

c. *Heart rate.*

For average HR, a two-way ANOVA revealed a main effect of time, $F(1, 54) = 5.914$, $p < 0.05$, such that average HR was smaller at the initial smoking session than at Visit 3. This initial analysis also showed a main effect of affective category, $F(2, 53) = 14.910$, $p < 0.001$. As hypothesized, average HR was smaller in response to negative than neutral slides, $F(1, 54) = 21.141$, $p < 0.001$ (Figure 3d).

For HR change, a two-way ANOVA revealed no main effect of time, $F(1, 54) = 0.324$, p = ns, though it did show a main effect of affective category, $F(2, 53) = 33.654$, $p < 0.001$. HR change was smaller (i.e., less negative) in response to positive than negative slides, $F(1, 54) = 10.824$, $p < 0.001$, and greater (i.e., more negative) in response to negative than neutral slides, $F(1, 54) = 60.763$, $p < 0.001$ (Figure 3e).

2. **Change in nicotine dependence as a covariate.**

a. *Startle eyeblink response.*

For average SER magnitude, a two-way ANCOVA, controlling for change in nicotine dependence, revealed no main effect of time, $F(1, 54) = 2.496$, p = ns, or affective category, $F(2, 53) = 2.605$, p = ns.

For SER amplitude, a two-way ANCOVA, controlling for change in nicotine dependence, revealed no main effect of time, $F(1, 54) = 0.876$, p = ns, or affective category, $F(2, 53) = 1.895$, p = ns.

For SER latency, a two-way ANCOVA, controlling for change in nicotine dependence, revealed a main effect of time, $F(1, 54) = 4.749$, $p < 0.05$, such that SER latency was greater at the initial smoking session than at Visit 3. This initial analysis also showed a main effect of affective category, $F(2, 53) = 3.144$, $p = 0.50$. These main effects were qualified by an interaction, $F(2, 53) = 3.386$, $p < 0.05$, such that SER latency in response to neutral slides decreased more over time than response to negative slides, $F(2, 53) = 4.006$, $p < 0.01$ (Figure 4a).

b. ***Skin conductance level.***

For average SC level, a two-way ANCOVA, controlling for change in nicotine dependence, revealed no main effect of time, $F(1, 54) = 0.106$, p = ns, or affective category, $F(2, 53) = 0.365$, p = ns.

For SC level change, a two-way ANCOVA, controlling for change in nicotine dependence, revealed no main effect of time, $F(1, 54) = 0.170$, p = ns, or affective category, $F(2, 53) = 0.249$, p = ns.

c. ***Heart rate.***

For average HR, a two-way ANCOVA, controlling for change in nicotine dependence, revealed no main effect of time, $F(1, 54) = 1.947$, p = ns, though it did show a main effect of affective category, $F(2, 53) = 7.468$, $p = 0.001$. As hypothesized, average HR was smaller in response to negative than neutral slides, $F(1, 54) = 11.658$, $p = 0.001$ (Figure 4b).

For HR change, a two-way ANCOVA, controlling for change in nicotine dependence, revealed no main effect of time, $F(1, 54) = 0.097$, p = ns, though it did show a main effect of affective category, $F(2, 53) = 16.403$, $p < 0.001$. HR change was smaller (i.e., less negative) in response to positive than negative slides, $F(1, 54) = 6.149$, $p < 0.05$, and greater (i.e., more negative) in response to negative than neutral slides, $F(1, 54) = 32.386$, $p < 0.001$ (Figure 4c).

3. Change in nicotine dependence as a moderator of emotional response.

To test our hypothesis that change in nicotine dependence would moderate changes in emotional response over time, each indicator of emotional response during Visit 3 was regressed onto the same emotional response variable during the initial smoking session, as well as change in nicotine dependence and their interaction, after controlling for smoking frequency, quantity, and recency.

a. ***Startle eyeblink response.***

In the analysis of SER magnitude, response at the initial smoking session did account for significant variance in response to all slides and for the negative-ITI difference score, $B = 0.002$, ts$(54) \geq 2.161$, ps < 0.05. Change in nicotine dependence was then added into the model and failed to contribute significant variance in all cases. In the final step of each analysis, the interaction between emotional response at the initial smoking session and change in nicotine dependence was entered into the model. For all affective categories and both difference scores, this interaction term did not account for additional variance in SER magnitude at Visit 3.

In the analysis of SER amplitude, response at the initial smoking session did account for significant variance in response to all slides, $B = 0.002$, ts$(54) \geq 5.007$, ps $<$

0.001. Change in nicotine dependence was then added into the model and failed to contribute significant variance in all cases. In the final step of each analysis, the interaction between emotional response at the initial smoking session and change in nicotine dependence was entered into the model. For all affective categories and both difference scores, this interaction term did not account for additional variance in SER magnitude at Visit 3.

In the analysis of SER latency, response at the initial smoking session did account for significant variance in response to positive slides only, $B = 0.009$, $t(54) = 3.844$, $p < 0.001$. Change in nicotine dependence was then added into the model and failed to contribute significant variance in all cases. In the final step of each analysis, the interaction between emotional response at the initial smoking session and change in nicotine dependence was entered into the model. For all affective categories and both difference scores, this interaction term did not account for additional variance in SER latency at Visit 3.

b. ***Skin conductance level.***

In the analysis of average SC level, response at the initial smoking session did not account for significant variance in response at Visit 3. Change in nicotine dependence was then added into the model and contributed significant variance for negative slides only, $B = 0.000$, $t(54) = -2.273$, $p < 0.05$, such that those with low changes in nicotine dependence showed low average SC level in response to negative slides overall. That is, smokers who did not develop greater nicotine dependence over time maintained a low level of general arousal in response to negative images. In the final step of each analysis, the interaction between emotional response at the initial smoking session and change in

nicotine dependence was entered into the model. For all affective categories, this interaction term did not account for additional variance in average SC level at Visit 3.

In the analysis of SC level change, response at the initial smoking session did not account for significant variance in response at Visit 3. Change in nicotine dependence was then added into the model and failed to contribute significant variance in all cases. In the final step of each analysis, the interaction between emotional response at the initial smoking session and change in nicotine dependence was entered into the model. For all affective categories, this interaction term did not account for additional variance in SC level change at Visit 3.

c. ***Heart rate.***

In the analysis of average HR, response at the initial smoking session did account for significant variance in response at Visit 3 for all slides, $B = 0.004$, ts$(54) \geq 4.939$, ps < 0.001. Change in nicotine dependence was then added into the model and failed to contribute significant variance in all cases. In the final step of each analysis, the interaction between emotional response at the initial smoking session and change in nicotine dependence was entered into the model. For all affective categories, this interaction term accounted for additional variance in average HR at Visit 3, $B = -0.001$, ts$(54) \geq -2.642$, ps ≤ 0.01 (Figures 5a-c). Analysis of simple slopes revealed that smokers with little change in nicotine dependence over time had similarly high average HR at both sessions, $B = 0.005$, ts$(54) \geq 5.791$, ps < 0.001 (Figures 6a-c).

In the analysis of HR change, response at the initial smoking session did account for significant variance in response at Visit 3 for neutral slides only, $B = -0.004$, $t(54) = -2.009$, $p = 0.05$. Change in nicotine dependence was then added into the model and

failed to contribute significant variance in all cases. In the final step of each analysis, the interaction between emotional response at the initial smoking session and change in nicotine dependence was entered into the model. For all affective categories, this interaction term did not account for additional variance in HR change at Visit 3.

C. Neversmokers

1. Emotional response over time.

a. *Startle eyeblink response.*

For SER magnitude, a two-way ANOVA revealed a main effect of time, $F(1, 54) = 4.803$, $p < 0.05$, such that SER magnitude was greater at the matched session than at Visit 3. This initial analysis also showed a main effect of affective category, $F(2, 53) = 5.671$, $p < 0.01$. As hypothesized, SER magnitude was greater in response to negative slides than neutral slides, $F(1, 54) = 8.638$, $p < 0.01$ (Figure 7a).

For SER amplitude, a two-way ANOVA revealed no main effect of time, $F(1, 54) = 1.869$, p = ns, or affective category, $F(2, 53) = 1.150$, p = ns.

For SER latency, a two-way ANOVA revealed a main effect of time, $F(1, 54) = 6.021$, $p < 0.05$, such that SER latency was greater at the matched session than at Visit 3. This initial analysis showed no main effect of affective category, $F(2, 53) = 0.454$, p = ns (Figure 7b).

b. *Skin conductance level.*

For average SC level, a two-way ANOVA revealed a main effect of time, $F(1, 54) = 11.960$, $p < 0.01$, such that average SC level was greater at the matched session than at Visit 3. This initial analysis showed no main effect of affective category, $F(2, 53) = 1.852$, p = ns (Figure 7c).

For SC level change, a two-way ANOVA revealed no main effect of time, $F(1, 54) = 0.669$, p = ns, or affective category, $F(2, 53) = 2.078$, p = ns.

c. *Heart rate.*

For average HR, a two-way ANOVA revealed no main effect of time, $F(1, 54) = 0.005$, p = ns, though it did show a main effect of affective category, $F(2, 53) = 6.236$, $p < 0.01$. As hypothesized, average HR was greater in response to positive slides than negative slides, $F(1, 54) = 6.204$, $p < 0.05$, and smaller in response to negative than neutral slides, $F(1, 54) = 15.086$, $p = 0.001$ (Figure 7d).

For HR change, a two-way ANOVA revealed no main effect of time, $F(1, 54) = 2.181$, p = ns, or affective category, $F(2, 53) = 2.064$, p = ns.

2. Initial emotional response as a predictor of later emotional response.

To test our hypothesis that emotional response would be reliable over time, indicators of emotional response at Visit 3 were regressed onto the analogous measures from the matched session.

a. *Startle eyeblink response.*

In the analysis of SER magnitude, response during the matched session accounted for significant variance in response to all slides and both the negative-neutral and negative-ITI difference scores during Visit 3, $B = 0.004$, ts$(30) \geq 3.283$, ps ≤ 0.001 (Figures 8a-c).

In the analysis of SER amplitude, response during the matched session accounted for significant variance in response to positive and negative slides and the negative-ITI difference score during Visit 3, $B = 0.004$, ts$(30) \geq 2.496$, ps < 0.05 (Figures 8d-e).

In the analysis of SER latency, response during the matched session accounted for significant variance in response to all slides during Visit 3, $B = 0.007$, ts$(30) \geq 2.810$, ps < 0.01 (Figures 8f-g).

b. ***Skin conductance level.***

In the analysis of average SC level, response during the matched session accounted for significant variance in response to negative and neutral slides during Visit 3, $B = 0.002$, ts$(30) \geq 2.147$, ps < 0.05 (Figures 8h-i).

In the analysis of SC level change, response during the matched session failed to account for significant variance in response during Visit 3 in all cases.

c. ***Heart rate.***

In the analysis of average HR, response during the matched session failed to account for significant variance in response during Visit 3 in all cases.

In the analysis of HR change, response during the matched session accounted for significant variance in response to neutral slides only during Visit 3, $B = 0.003$, $t(30) = 2.130$, $p < 0.05$ (Figure 8j).

IV. DISCUSSION

The overall goal of the present study was to determine whether the affective benefits derived from smoking change over time in adolescent smokers and whether the development of nicotine dependence might relate to these changes. For smokers, we anticipated that emotional response would increase across visits, though the affective pattern (e.g., greatest SER magnitude in response to negative slides) would remain stable. Further, we hypothesized that change in nicotine dependence would moderate emotional response over time such that those with increased nicotine dependence would experience

less affective benefit from a single cigarette over time, and therefore, exhibit greater emotional response at Visit 3. In contrast to this hypothesized temporal pattern for smokers, we anticipated that emotional response would decrease over time for neversmokers, though the affective pattern would remain stable. We also hypothesized that emotional response would be reliable across sessions, such that emotional response at the matched session would predict similar responses at Visit 3.

A. Affective Patterns of Psychophysiological Measures

Where apparent, affective patterns in emotional response were as expected. For smokers, both SER magnitude and amplitude were smaller in response to positive and neutral slides than in response to negative slides. Further, average HR was smaller in response to negative than neutral slides, even after controlling for change in nicotine dependence. Finally, HR change was smaller (i.e., less negative) in response to positive and neutral slides than in response to negative slides, even after controlling for change in nicotine dependence. Similarly, in neversmokers, SER magnitude was greater in response to negative than neutral slides, though there were no affective differences for SER amplitude or latency. Further, average HR was greater in response to positive and neutral slides than in response to negative slides, as hypothesized.

Most of these observed patterns are well established, as the SER has previously been shown to increase significantly from neutral to negative slides (Bradley et al., 1988; Cook et al., 1991; Lang et al., 2001; Vrana et al., 1988) and from positive to neutral slides (Bradley et al., 1988; Vrana et al. 1988). This effect also grows stronger with increased arousal level (Lang, 1995), as indexed by average HR in the current study. Prior research with children and adolescents has shown similar response patterns (McManis et al.,

2001), and the current findings add to this growing literature. Conceptually, this affective pattern documents the "defense motivation system," which calls for greater response among those experiencing negative affect, due to both fear and the desire to defend oneself. As SER is potentiated, SC increases with arousal, and HR decelerates before accelerating to prepare for action (Lang et al., 2000).

There are several notable exceptions to these expected results, however. In smokers, SER latency, which is generally smallest in response to negative slides as the natural defense response is activated, showed a trend for affective state such that it was smaller in response to positive than negative slides. The contradictory implications of SER latency vs. magnitude and amplitude might indicate a measurement problem for the former variable. Indeed, most studies of the SER emphasize magnitude (e.g., Lang et al., 1990), as SER latency has proven less reliable than other SER measures (Vrana et al., 1988). Further, SER latency is more influenced by arousal and attention, as compared with valence (Cook et al., 1991), and so might not be as pure an indicator of emotional response.

Also of note, several psychophysiological measures did not show any affective pattern. In neversmokers, there were no affective patterns for either SER magnitude or amplitude, which are closely related. It is possible that low power, due to a small sample size, prevented detection of these differences. Perhaps more interestingly, average SC level and SC level change, which are also closely related, failed to differ by affective category across both groups. SC, like HR, is an index of general arousal and has been shown to increase reliably for affective, as compared with neutral, images (Bradley, Codispoti, Cuthbert, & Lang, 2001). Unlike HR, however, SC is relatively unaffected by

specific valences, whereas HR might be able to distinguish among different emotions (Ekman et al., 1983; Levenson, 1992). Therefore, it is possible that SC was not as sensitive as HR when detecting affective differences in arousal, as the selected slides were specifically chosen to be appropriate for adolescents (i.e., lower in arousal). Our next aim was to examine these responses over time in both smokers and neversmokers.

B. Reliability of Emotional Response Over Time

Patterns of emotional response over time were inconsistent. As expected in smokers, SER latency was greater at the initial smoking session than Visit 3, indicating increased response to affective images over time. Given the fact that acute nicotine administration inhibits the SER in smokers (Cinciripini et al., 2006; Mueller et al., 1998), and that development of tolerance is a core construct of nicotine dependence, this finding seems to support the idea that negative affect might not be as easily managed with the same dose of nicotine over time if nicotine dependence has increased. After controlling for changes in nicotine dependence, however, this effect of time was qualified by a significant interaction with affective differences such that SER latency in response to neutral slides decreased more over time than response to negative slides. This indicates that smokers' reactions to neutral and negative slides became more similar over time, perhaps speaking to an increasing tendency towards negative affect and attendant increases in smoking behavior (Wills et al., 2002).

This expected finding, however, is challenged by most other psychophysiological measures. Unexpectedly, for smokers, SER magnitude and amplitude, which are closely related, were greater at the initial smoking session than Visit 3 whereas average HR increased over time. These patterns suggest that smokers responded more strongly to

affective slides at the initial smoking session than at Visit 3. As before, it might be that SER latency represents an aberrant finding and that emotional response actually decreased over time in smokers. This would mirror the pattern found in neversmokers, for whom, as hypothesized, both average SER magnitude and average SC level were greater at the matched session than at Visit 3.

Decreased psychophysiological response to affective slides over time might also reflect a long-term decrease of emotional response in all participants, though previous studies have only addressed the SER throughout a single session (Bradley et al., 1993) or across multiple sessions within the same day (i.e., 3 separate sessions within 8 hours; Abel et al., 1998). In addition, the single study that examined emotional response over multiple days was primarily concerned with reactions to novel stimuli (Larson et al., 2000). Still, it is possible that after one or two previous visits, the startle paradigm held reduced novelty for participants and so was less effective in eliciting strong emotional responses at Visit 3. Only the unexpected finding that SER latency decreased over time challenges this conclusion. Again, as no other SER measures supported this implication, SER latency might represent an unreliable finding in this case. The final aim of the current study was to examine predictors (i.e., initial emotional response) and moderators (i.e., change in nicotine dependence for smokers) of response to affective images over time.

C. Predictors and Moderators of Emotional Response

In smokers, SER magnitude, amplitude, and latency, as well as average HR and HR change, were reliable over time, after controlling for smoking frequency, quantity, and recency. Further, change in nicotine dependence predicted average SC level for

negative slides only, such that those with little change in nicotine dependence over time showed low average arousal in response to negative slides. With regard to moderation, however, change in nicotine dependence affected only average HR over time: those with little change in nicotine dependence over time had similarly high average HR at both sessions. Taken together, these findings suggest that those who do not continue to develop nicotine dependence have relatively reliable emotional response. In this case, a lack of tolerance might make the same dose of nicotine just as effective in regulating emotion over time. However, it is important to note that change in nicotine dependence affected only measures of general arousal. It might be unreasonable to expect a gross measure like change in nicotine dependence to affect SER, as this is a relatively specific measure of emotion. In contrast, a more global measure like SC or HR might have been nonspecific enough to capture changes in overall response due to arousal. We must take care not to over-interpret these findings, however, as no other indices of emotional response support this conclusion.

Finally, for neversmokers, SER magnitude, amplitude, and latency, as well as HR change and average SC level, were similarly reliable over time. This indicates a relative stability in general emotional response and supports findings from a previous study in an undergraduate population (Larson et al., 2000). As in the project run by Larson and colleagues (2000), a subset of participants in the current study were exposed to a different set of slides at each visit, and this design has been linked to stable SER as measured on different days. It is also possible that the startle paradigm had lost its novelty by the third visit and so was less effective in eliciting any sort of emotional response.

D. Limitations and Summary

Despite the strengths of the current study design, there are limitations. As with any laboratory study, external validity might be questioned. The relationship between emotion and smoking is influenced, not just through the pharmacological effects of nicotine, but through more general contextual factors as well. A sister study within the larger program grant has examined mood immediately before and after a smoking episode using ecological momentary assessment (EMA). Results indicate that, prior to smoking, adolescents felt significantly less positive and more negative than they did at other random assessment timepoints (Mermelstein, Hedeker, & Weinstein, 2010). The lab-based data presented here as well as previous projects from our lab (Kassel et al., In press, 2011), examine the next step in this emotion regulation process by indicating that these adolescent smokers actually do reap the anticipated benefits from smoking, as evidenced by affective patterns in various psychophysiological measures. Another limitation concerns sample size, which was relatively low in both the smoker and neversmoker groups. Further, a nicotine dependence change score might not be the most sensitive moderator of emotional response. Future analyses using multi-level models that focus on individual variability could better adjust for missing data points and changes in nicotine dependence. Other potential moderators of emotional response (e.g., affective outcome expectancies, personality/temperament, gender, etc.; Colder, Chassin, Lee, & Villalta, 2010) should be examined as well.

Overall, these results provide an important point of departure for future studies and analyses. The findings are mixed: while there were expected results in terms of affective patterns in SER, SC, and HR measures, emotional response over time was less reliable. For both smokers and neversmokers, SER latency was greater at the first session than the second, which indicates less response to affective images over time and contradicts findings from all other

measures, though this might be due to its relative unreliability. Further, change in nicotine dependence predicted average SC level and moderated emotional response over time as indexed by average HR only. Still, we were able to confirm previous research in both adolescents and adults regarding affective patterns in psychophysiological measures while continuing to ask questions about the association between the development of nicotine dependence and emotional response over time. This relationship remains unclear and in need of further research, as it seems an important piece of the theoretical puzzle surrounding escalation to continued and chronic cigarette smoking.

TABLE I.

PARTICIPANT CHARACTERISTICS

	Smokers (n=64)	**Neversmokers (n=36)**
General Characteristics		
Age at baseline (years)	15.7 (0.6)	15.5 (0.5)
Gender (male)	36 (56.3%)	13 (36.1%)
Race (Caucasian)	50 (78.1%)	23 (63.9%)
Ethnicity (not Hispanic/Latino)	54 (84.4%)	33 (91.7%)
	Baseline	**Visit 3**
Smoking Behavior[a]		
Smoking frequency (out of the last 30 days)		
2 to 3 days	3 (4.7%)	1 (1.6%)
4 to 5 days	3 (4.7%)	0 (0%)
6 to 7 days	2 (3.1 %)	2 (3.1%)
8 to 10 days	8 (12.5%)	5 (7.8%)
11 to 20 days	10 (15.6%)	9 (14.1%)
21 to 29 days	16 (25.0%)	13 (20.3%)
All 30 days	22 (34.4%)	34 (53.1%)
Smoking quantity (cigarettes/day)		
Less than one	1 (1.6%)	2 (3.1%)
1	4 (6.3%)	2 (3.1%)
2	14 (21.9%)	8 (12.5%)
3	13 (20.3%)	11 (17.2%)
4	6 (9.4%)	5 (7.8%)
5	9 (14.1%)	6 (9.4%)
6 to 10	13 (20.3%)	20 (21.3%)
11 to 19	3 (4.7%)	10 (15.6%)
20	0 (0%)	0 (0%)
More than 20	1 (1.6%)	0 (0%)
Smoking recency		
In the last 24 hours	47 (73.4%)	57 (89.1%)
In the last 24 hours to 7 days	13 (20.3%)	7 (10.9%)
In the past 8 to 14 days	3 (4.7%)	0 (0%)
In the past 15 to 30 days	1 (1.6%)	0 (0%)
Nicotine Dependence[b]	2.7 (1.3)	3.3 (1.5)

Note: Data are Mean (SD) or n (%).

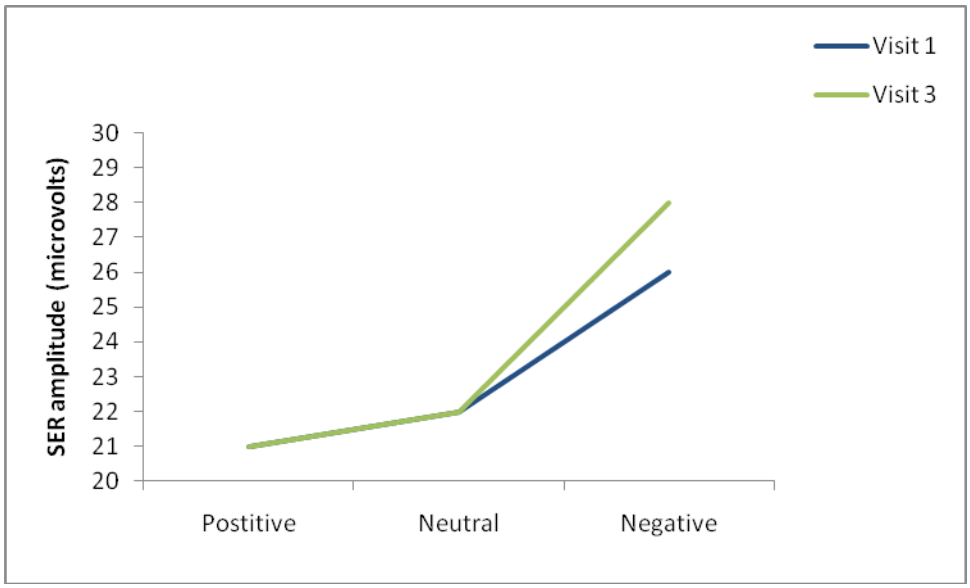
[a]All smoking behavior was gathered using a series of multiple-choice questions. See Appendix C for information on individual items.

[b]Assessed using the Modified Fagerstrom Tolerance Questionnaire (mFTQ)

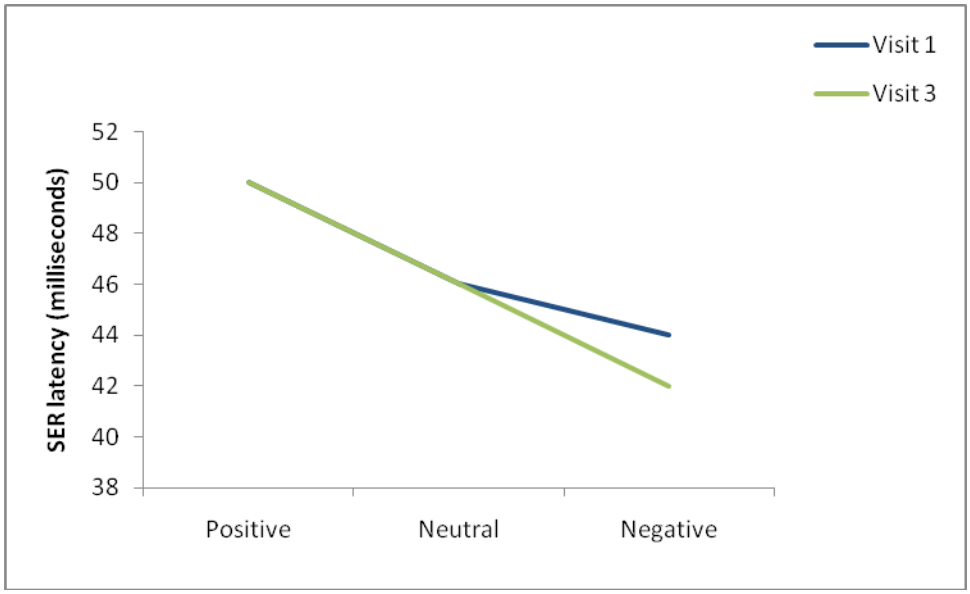
FIGURE I.

PREDICTED EMOTIONAL RESPONSE OVER TIME BY AFFECT IN SMOKERS

A. SER Amplitude



B. SER Latency



C. Average SC Level

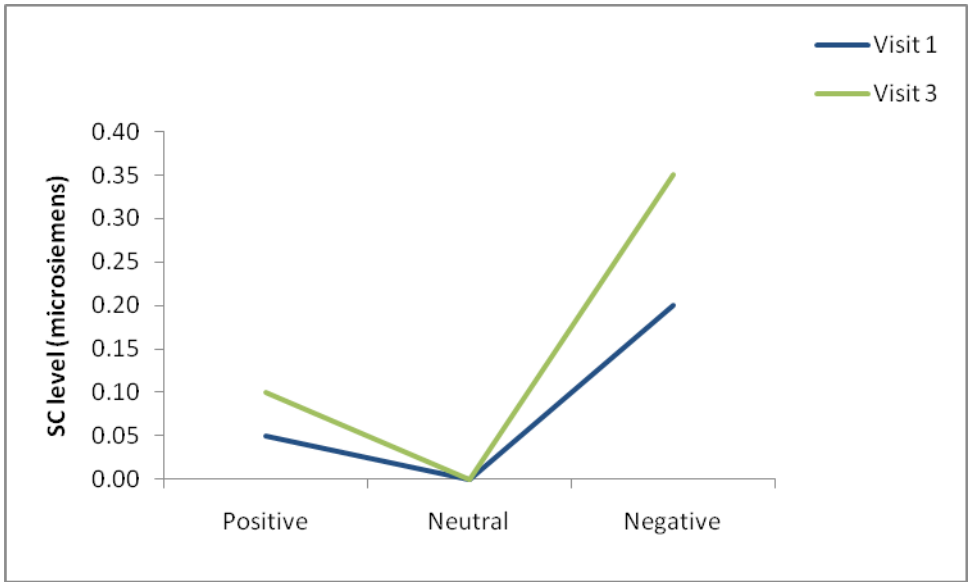


FIGURE II.

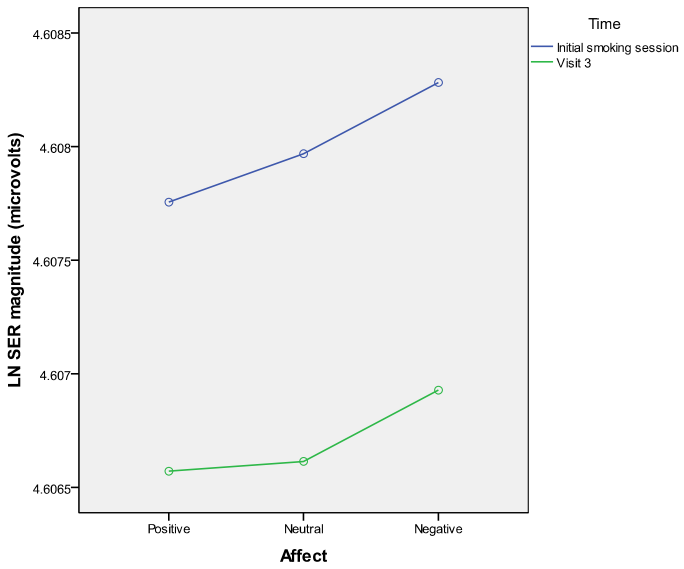
SESSION TIMELINE

Time (minutes)	Description
0	Participant arrival
1-20	Completion of informed consent, CO reading, and baseline self-report questionnaires
21-35	Electrode placement
35-37	Baseline measurement of heart rate (HR) and skin conductance (SC)
37	Pre-cigarette CO reading (smokers only)
38-42	*Ad lib* cigarette smoking (smokers only)
43	Post-cigarette CO reading (smokers only)
43-45	Post-cigarette measurement of HR and SC
45	Self-report questionnaires
46-58	Psychophysiological assessment of emotional response to affective stimuli (slides)
60	Self-report questionnaires
62-79	Slide viewing and rating
80	Self-report questionnaires
81-86	Compensation and debriefing

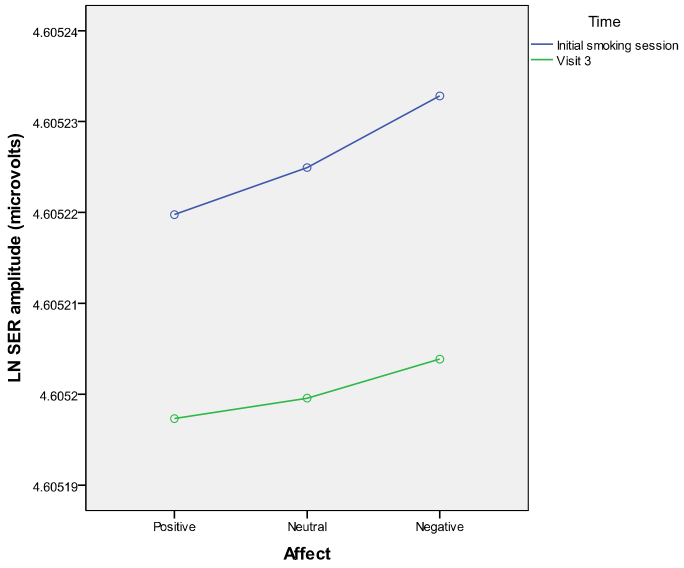
FIGURE III.

EMOTIONAL RESPONSE OVER TIME BY AFFECT IN SMOKERS

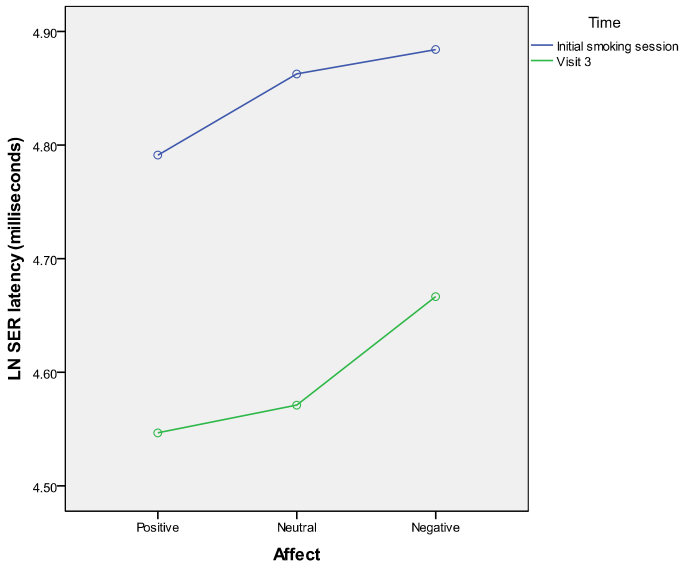
A. SER Magnitude



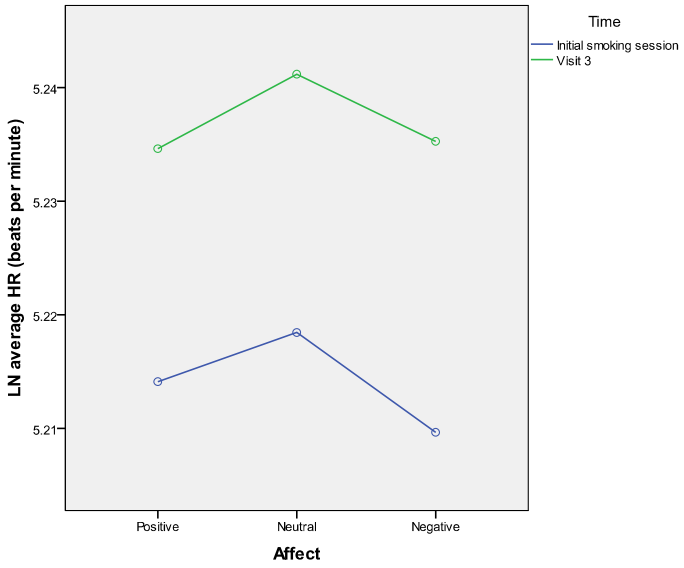
B. SER Amplitude



C. SER Latency



D. Average HR



E. HR Change

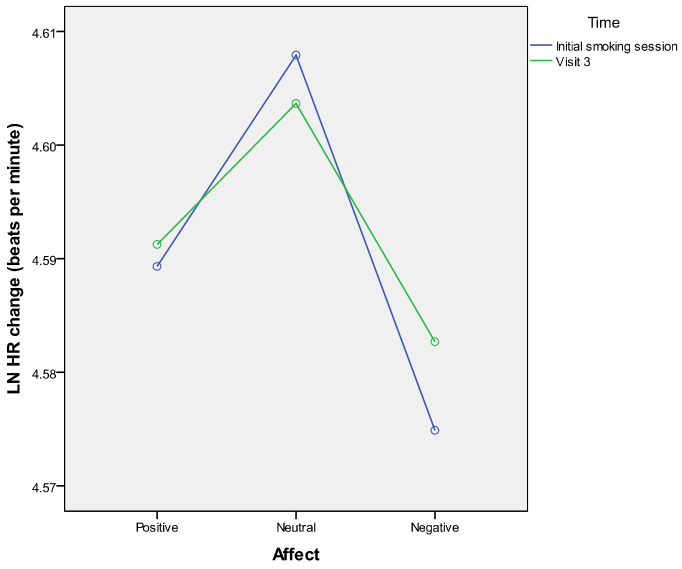
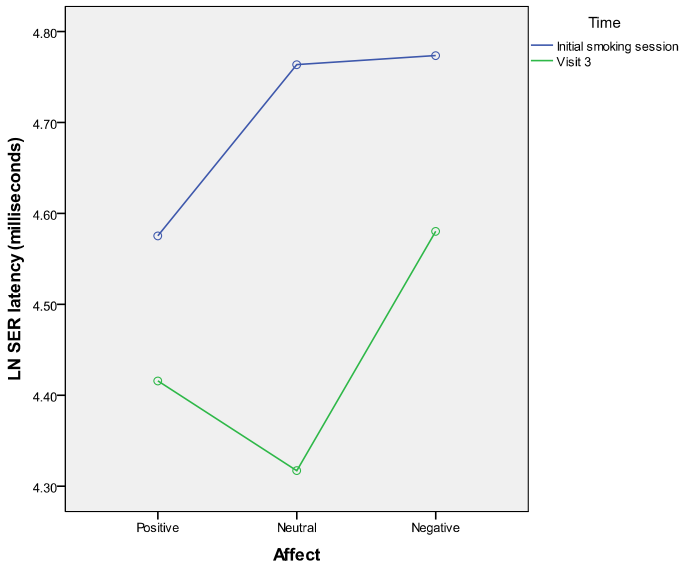


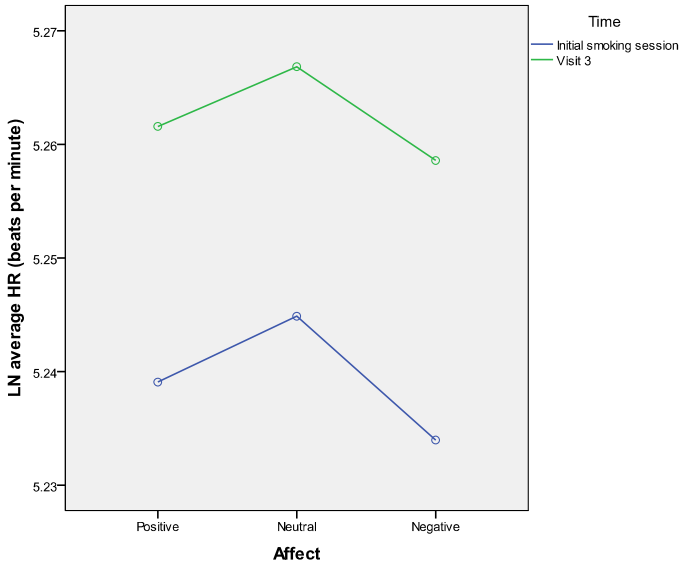
FIGURE IV.

EMOTIONAL RESPONSE OVER TIME BY AFFECT IN SMOKERS, CONTROLLING FOR CHANGE IN NICOTINE DEPENDENCE

A. SER Latency



B. Average HR



C. HR Change

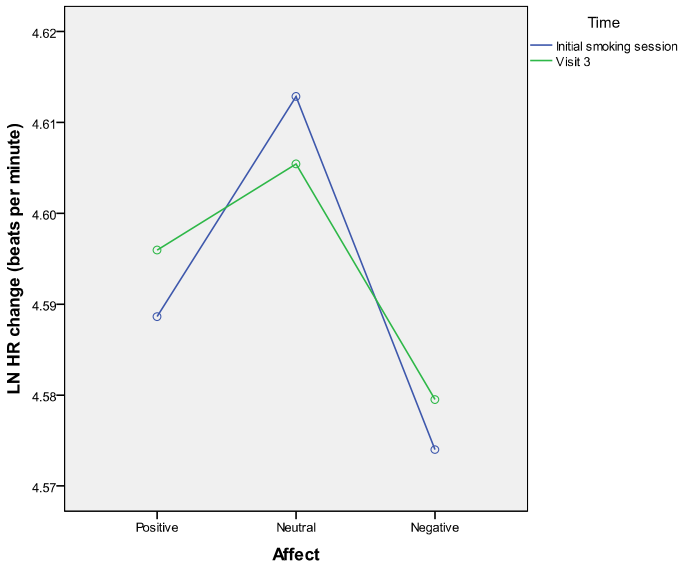
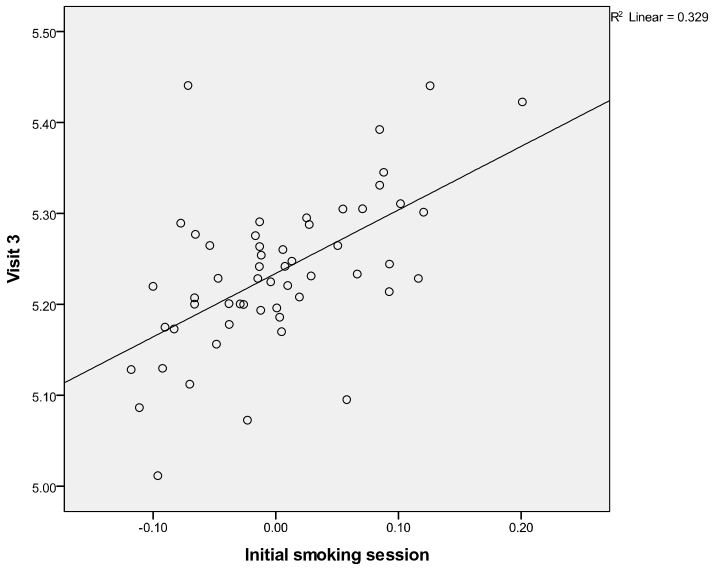


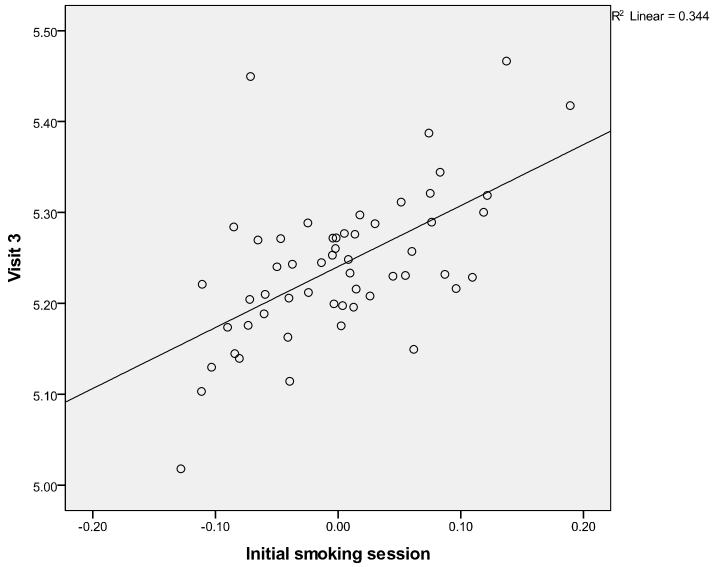
FIGURE V.

CHANGE IN NICOTINE DEPENDENCE AS A MODERATOR OF EMOTIONAL RESPONSE OVER TIME IN SMOKERS

A. Average HR for Positive Slides (beats per minute)



B. Average HR for Neutral Slides (beats per minute)



C. Average HR for Negative Slides (beats per minute)

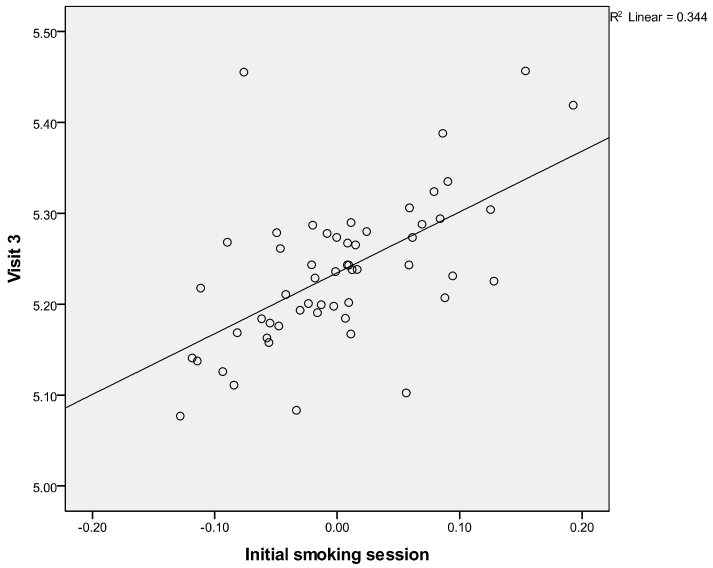
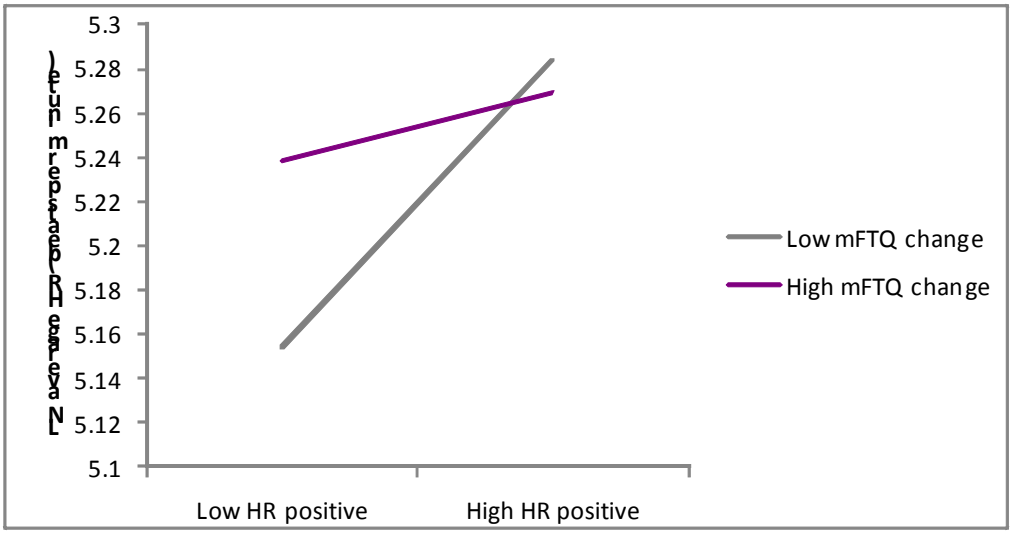


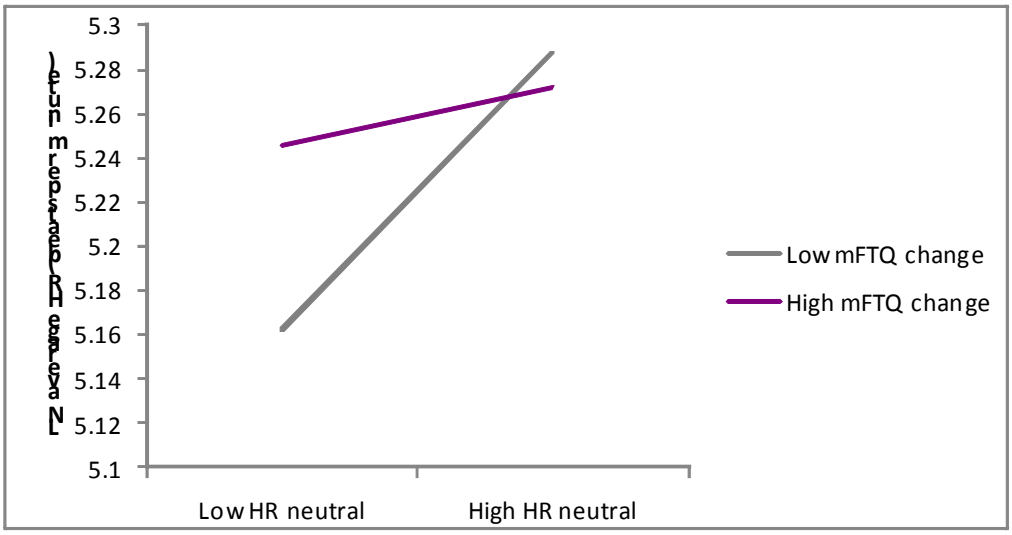
FIGURE VI.

SIMPLE SLOPES ANALYSIS FOR AVERAGE HR OVER TIME IN SMOKERS

A. Positive Slides



B. Neutral Slides



C. Negative Slides

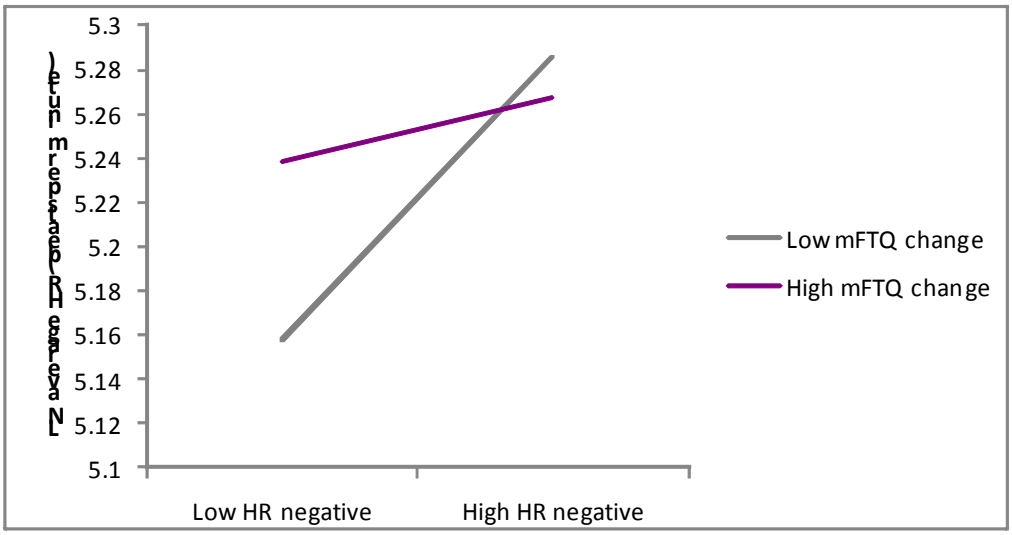
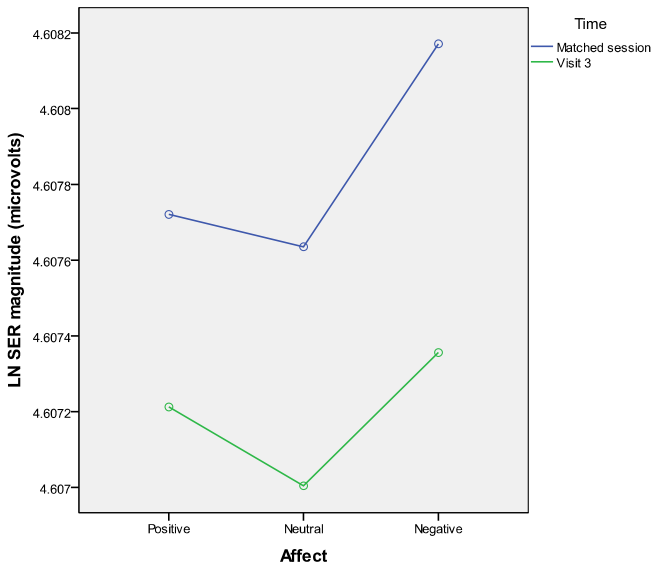


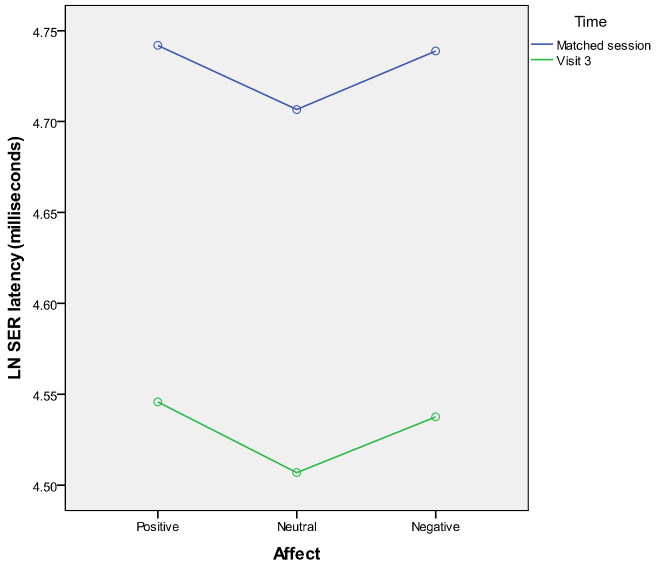
FIGURE VII.

EMOTIONAL RESPONSE OVER TIME BY AFFECT IN NEVERSMOKERS

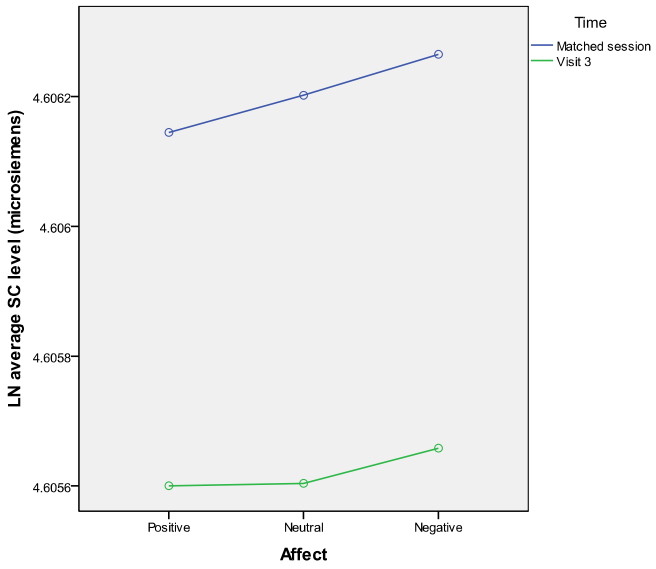
A. SER Magnitude



B. SER Latency



C. Average SC Level



D. Average HR

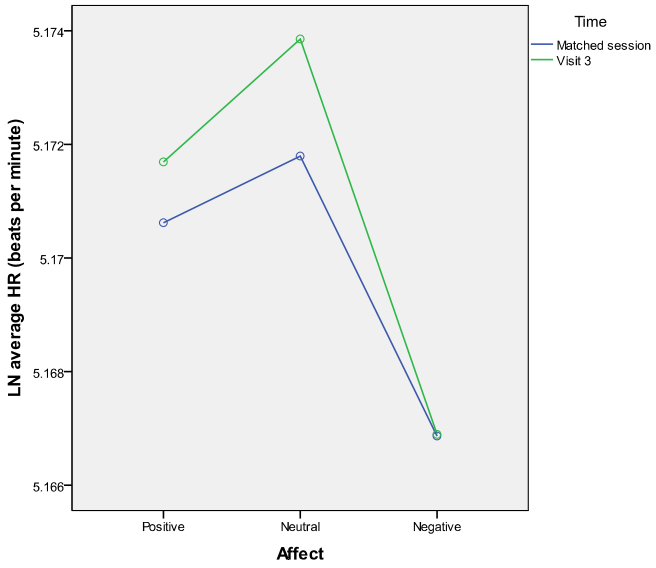
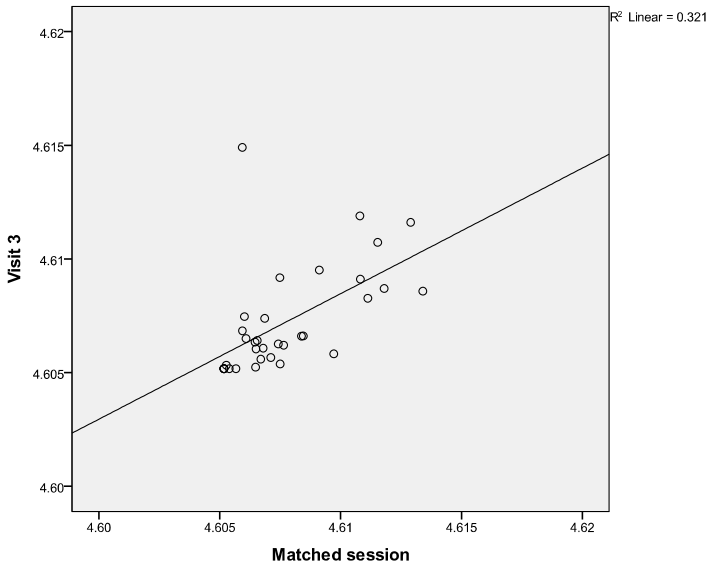

Time
Matched session
Visit 3
LN average HR (beats per minute)
5.174
5.172
5.17
5.168
5.166
Positive
Neutral
Negative
Affect

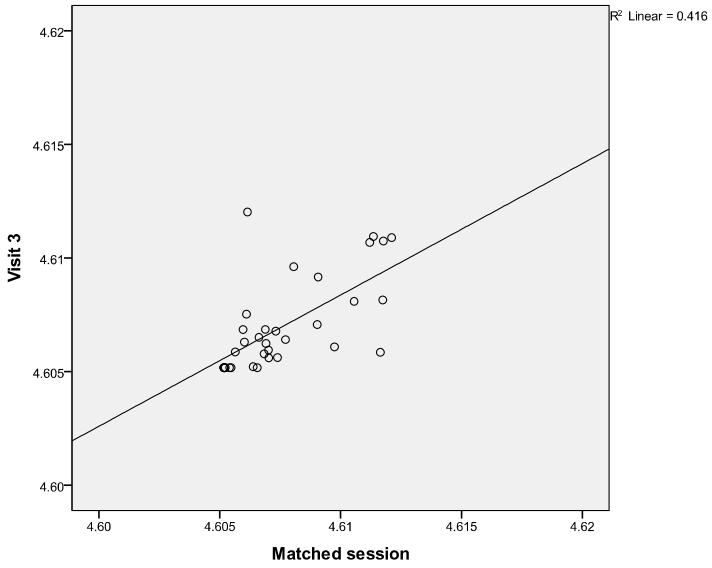
FIGURE VIII.

INITIAL EMOTIONAL RESPONSE AS A PREDICTOR OF LATER EMOTIONAL RESPONSE IN NEVERSMOKERS

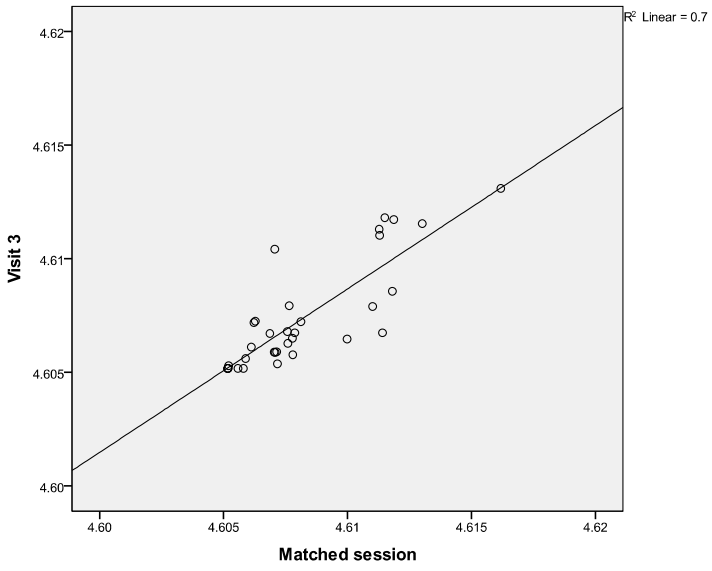
A. SER Magnitude for Positive Slides (microvolts)



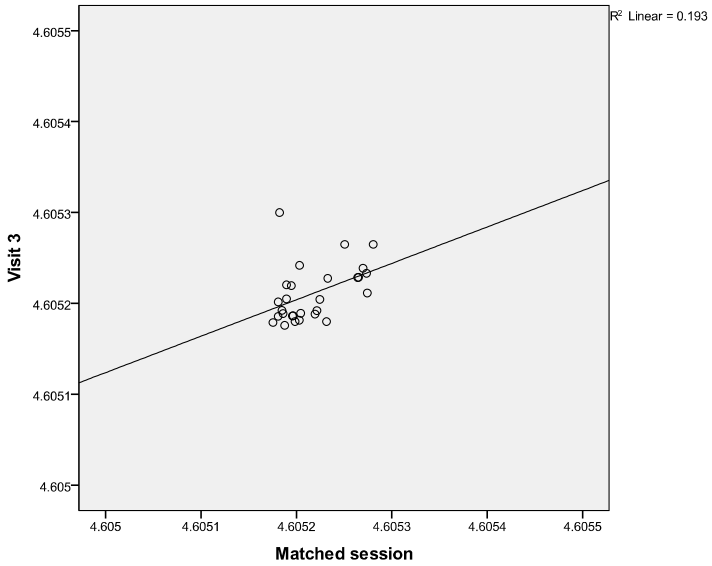
B. SER Magnitude for Neutral Slides (microvolts)



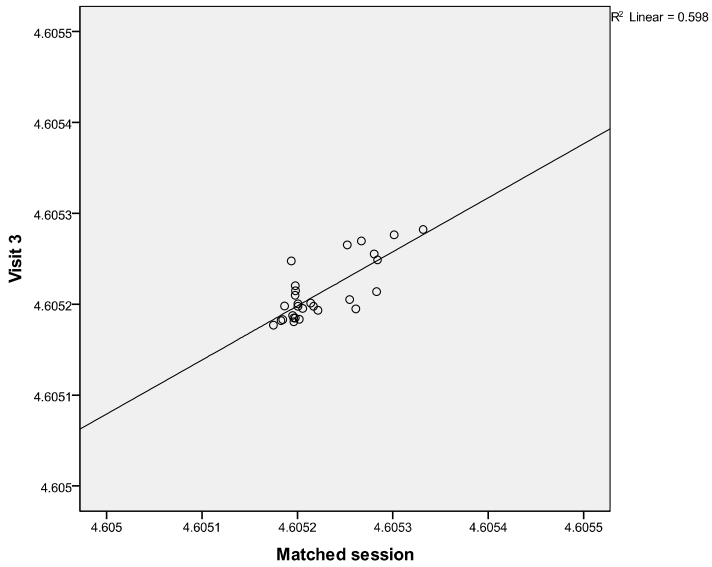
C. SER Magnitude for Negative Slides (microvolts)



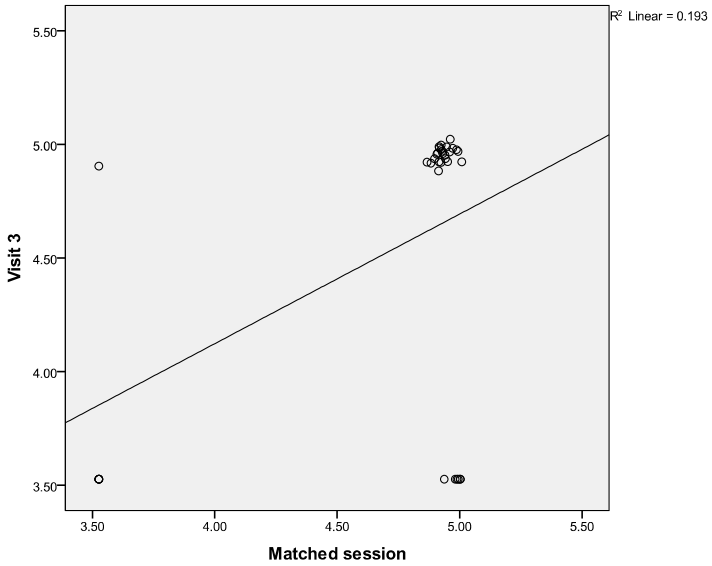
D. SER Amplitude for Positive Slides (microvolts)



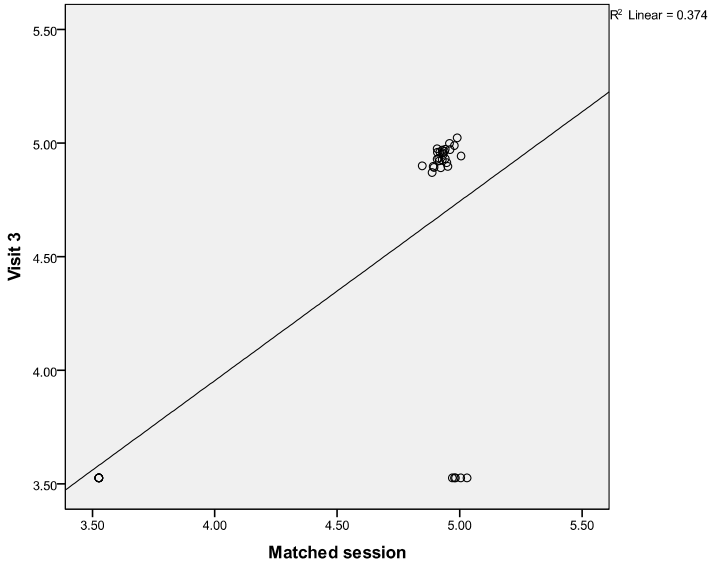
E. SER Amplitude for Negative Slides (microvolts)



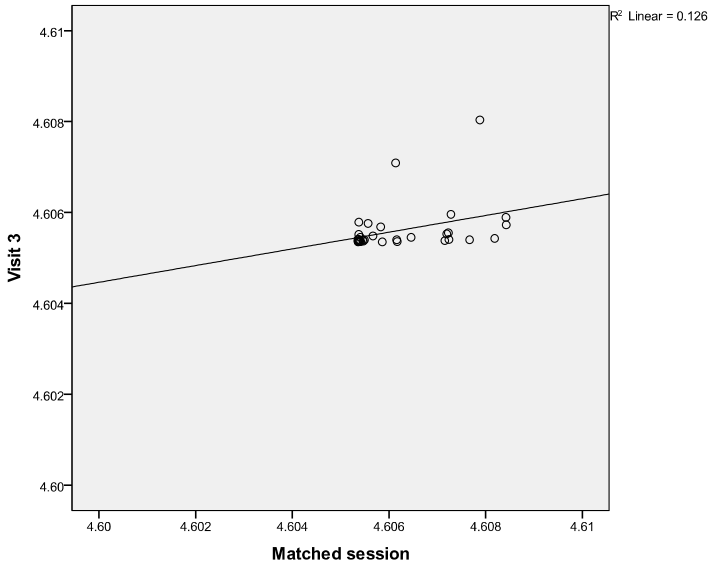
F. SER Latency for Positive Slides (milliseconds)



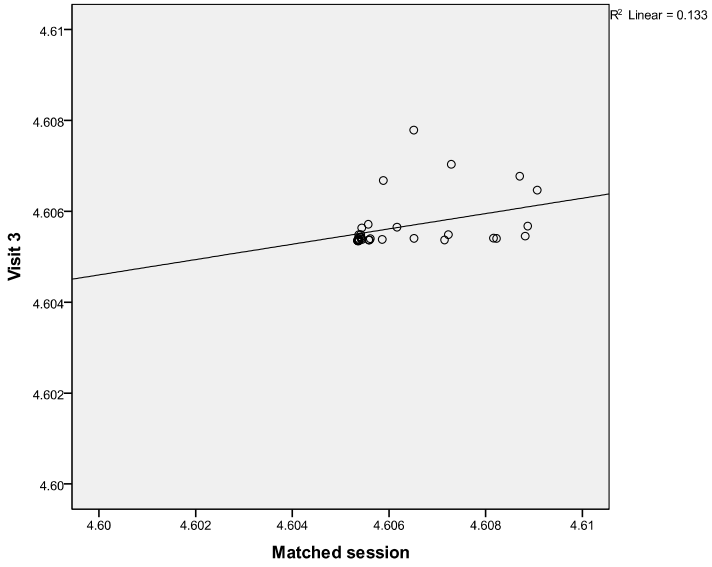
G. SER Latency for Negative Slides (milliseconds)



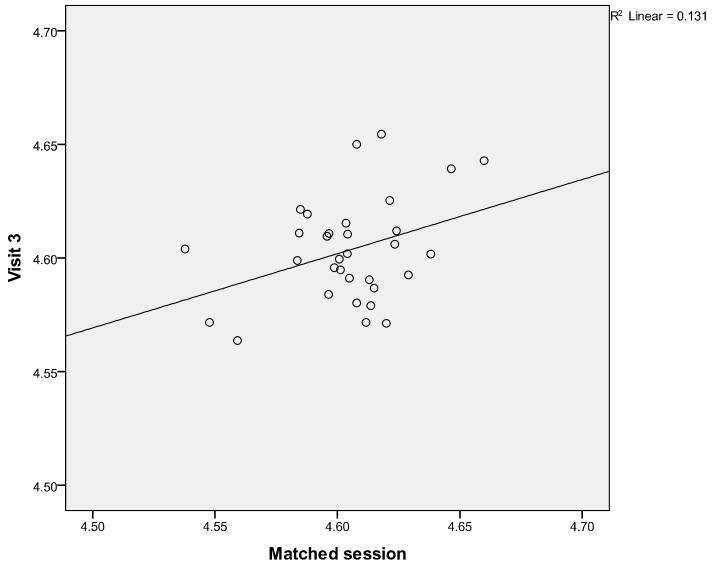
H. Average SC Level for Neutral Slides (microsiemens)



I. Average SC Level for Negative Slides (microsiemens)



J. HR Change for Neutral Slides (beats per minute)



CITED LITERATURE

Abel, K., Waikar, M., Pedro, B., Hemsley, D., & Geyer, M. (1998). Repeated testing of prepulse inhibition and habituation of the startle reflex: A study in healthy human controls. *Journal of Psychopharamcology, 12*, 330-337.

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: Sage.

Baker, T.B., Piper, M.E., McCarthy, D.E., Majeskie, M.R., & Fiore, M.C. (2004). Addiction motivation reformulated: An affective processing model of negative reinforcement. *Psychological Review, 111*, 33-51.

Blumenthal, T.D., Cuthbert, B.N., Filion, D.L., Hackley, S., Lipp, O.V., & Von Boxtel, A. (2005). Committee report: Guidelines for human startle eyeblink electromyographic studies. *Psychophysiology, 42*, 1-15.

Bradley, M.M., Codispoti, M., Cuthbert, B.N., & Lang, P.J. (2001). Emotion and motivation I: Defensive and appetitive reactions in picture processing. *Emotion, 1*, 276-298.

Bradley, M. M., Cuthbert, B. N., & Lang, P. J. (1988). Lateral presentation of acoustic startle stimuli in a varying affective foreground [Abstract]. *Psychophysiology, 25*, 436.

Bradley, M.M., Cuthbert, B.N., & Lang, P.J. (1990). Startle reflex modification: emotion or attention? *Psychophysiology, 27*, 513-522.

Bradley, M.M., Lang, P.J., & Cuthbert, B.N. (1993). Emotion, novelty, and the startle reflex: Habituation in humans. *Behavioral Neuroscience, 107*, 970-980.

Brown, J.S., Kalish, H.I., & Farber, I.E. (1951). Conditioned fear as revealed by magnitude of startle response to an auditory stimulus. *Journal of Experimental Psychology, 41*, 317-328.

Cinciripini, P.M., Robinson, J.D., Carter, B.L., Lam, C., Wu, X., de Moor, C.A., Baile, W.F., & Wetter, D.W. (2006). The effects of smoking deprivation and nicotine administration on emotional reactivity. *Nicotine & Tobacco Research, 8*, 379-392.

Colder, C.R., Chassin, L., Lee, M.R., & Villalta, I.K. (2010). Developmental perspectives: Affect and adolescent substance use. In J.D. Kassel (Ed.), *Substance use and emotion* (pp. 109-135). Washington, D.C.: American Psychological Association.

Cook, E.W., Hawk, L.W., Davis, T.L., & Stevenson, V.E. (1991). Affective individual differences and startle reflex modulation. *Journal of Abnormal Psychology, 100*, 5-13.

Corrigall, W.A., Zack, M., Eissenberg, T., Belsito, L., & Scher, R. (2001). Acute subjective and physiological responses to smoking in adolescents. *Addiction, 96*, 1409-1417.

Costello, E.J., Mustillo, S., Erkanli, A., Keeler, G., & Angold, A. (2003). Prevalence and development of psychiatric disorders in childhood and adolescence. *Archives of General Psychiatry, 60*, 837-844.

Davis, M., & Astrachan, D.I. (1978). Conditioned fear and startle magnitude: Effects of different footshock or backshock intensities used in training. *Journal of Experimental Psychology: Animal Behavior Processes, 4*, 95-103.

Davis, M., Hitchcock, J., & Rosen, J. (1987). Anxiety and the amygdala: Pharmacological and anatomical analysis of the fear potentiated startle paradigm. In G.H. Bower (Ed.), *Psychology of learning and motivation* (Vol. 21, pp. 263-305). San Diego, CA: Academic Press.

DiFranza, J. R. (2008). Hooked from the first cigarette. *Scientific American, 298*, 82-87.

Dugan, S., Lloyd, B., & Lucas, K. (1999). Stress and coping as determinants of adolescent smoking behavior. *Journal of Applied Social Psychology, 29*, 870 – 886.

Eissenberg, T., & Balster, R.L. (2000). Initial tobacco use episodes in children and adolescents: Current knowledge, future directions. *Drug and Alcohol Dependence, 59 (Supplement 1)*, S41-60.

Ekman P., Levenson, R.W., & Friesen, W.V. (1983). Autonomic nervous system activity distinguishes among emotions. *Science, 221*, 1208-1210.

Friedman, L.S., Lichtenstein, E., & Biglan, A. (1985). Smoking onset among teens: An empirical analysis of initial situations. *Addictive Behaviors, 10*, 1-13.

Frith, C.D. (1971). Smoking behavior and its relation to the smokers immediate response. *British Journal of Social and Clinical Psychology, 10*, 73-78.

Gilbert, D.G., & Hagen, R.L. (1980). The effects of nicotine and extraversion on self-report, skin conductance, electromyographic, and heart responses to emotional stimuli. *Addictive Behaviors, 5*, 247-257.

Gilbert, D.G., Rabinovich, N.E., Malpass, D., Mrnak, J., Riise, H., Adams, L., Sugai, C., & DevlescHoward, M. (2008). Effects of nicotine on affect are moderated by

stressor proximity and frequency, positive alternatives, and smoker status. *Nicotine & Tobacco Research, 10*, 1171-1183.

Greenwald, M.K., Bradley, M.M., Cuthbert, B.N., & Lang, P.J. (1998). Sensitization of the startle reflex in humans following aversive electric shock exposure. *Behavioral Neuroscience, 112*, 1069-1079.

Grillon, C., Avenevoli, S., Daurignac, E., & Merikangas, K.R. (2007). Fear-potentiated startle to threat, and prepulse inhibition among young adult nonsmokers, abstinent smokers, and nonabstinent smokers. *Biological Psychiatry, 62*, 1155-1161.

Grillon, C., & Davis, M. (1997). Fear-potentiated startle conditioning in humans: Effects of explicit and contextual cue conditioning following paired versus unpaired training. *Psychophysiology, 34*, 451-458.

Hamm, A.O., Greenwald, M.K., Bradley, M.M., & Lang, P.J. (1993). Emotional learning, hedonic change, and the startle probe. *Journal of Abnormal Psychology, 102*, 453-465.

Ikard, F.F., Green, O.E., & Horn, D. (1969). A scale to differentiate between types of smoking as related to the management of affect. *The International Journal of the Addictions, 4*, 649-659.

Ikard, F.F., & Tompkins, S.S. (1973). The experience of affect as a determinant of smoking behavior: A series of validity studies. *Journal of Abnormal Psychology, 81*, 172-181.

Johnston, L. D., O'Malley, P. M., Bachman, J. G., & Schulenberg, J. E. (2009). *Monitoring the Future national survey results on drug use, 1975–2008:Volume I, Secondary school students* (NIH Publication No. 09-7402). Bethesda, MD: National Institute on Drug Abuse.

Kassel, J.D., Evatt, D.P., Greenstein, J.E., Wardle, M.C., Yates, M.C., & Veilleux, J.C. (2007). The acute effects of nicotine on positive and negative affect in adolescent smokers. *Journal of Abnormal Psychology, 116*, 543-553.

Kassel, J.D., Stroud, L.R., & Paronis, C.A. (2003). Smoking, stress, and negative affect: Correlation, causation, and context across stages of smoking. *Psychological Bulletin, 129*, 270-304.

Kassel, J.D., Wardle, M.C., Veilleux, J.C., Greenstein, J.E., Heinz, A.J., Evatt, D.P., Roesch, L., Braun, A.R., Segawa, E., Hedeker, D., Berbaum, M., Mermelstein, R., & Blumenthal, T.D. (In press, 2011). The acute effects of cigarette smoking on emotional response in adolescent smokers: A multidimensional analysis. *Drug and Alcohol Dependence*.

Koval, J.J. & Pederson, L.L. (1999). Stress-coping and other psychosocial risk factors: A model for smoking in grade 6 students. *Addictive Behaviors, 24*, 207-218.

Landis, C., & Hunt, W.A. (1939). The startle pattern. New York: Ferrar.

Lang, P. J. (1995). The emotion probe: Studies of motivation and attention. *American Psychologist, 50*, 372-385.

Lang, P.J., & Bradley, M.M. (2010). Emotion and the motivational brain. *Biological Psychology, 84*, 437-450.

Lang, P.J., Bradley, M.M., & Cuthbert, B.N. (1990). Emotion, attention, and the startle reflex. *Psychological Review, 97*, 377-395.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1997). *International Affective Picture System (IAPS): Technical manual and affective ratings*. NIMH Center for the Study of Emotion and Attention.

Lang, P.J., Bradley, M.M., & Cuthbert, B.N. (1998). Emotion and motivation: Measuring affective perception. *Journal of Clinical Neurophysiology, 15*, 397-408.

Lang, P.J., Davis, M., & Öhman, A. (2001). Fear and anxiety: Animal models and human cognitive psychophysiology. *Journal of Affective Disorders, 61*, 137-159.

Lang, P.J., Öhman, A., & Vaitl, D. (1988). *The international affective picture system [photographic slides]*. Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.

Larson, C.L., Ruffalo, D., Nietert, J.Y., & Davidson, R.J. (2000). Temporal stability of the emotion-modulated startle response. *Psychophysiology, 37*, 92-101.

Levenson, R.W. (1992). Autonomic nervous system difference among emotions. *Psychological Science, 3*, 23-27.

Masterson, F.A., & Crawford, M. (1982). The defense motivation system: A theory of avoidance behavior. *The Behavioral and Brain Sciences, 5*, 661-696.

Mauss, I.B., & Robinson, M.D. (2009). Measures of emotion: A review. *Cognition and Emotion, 23*, 209-237.

McManis, M.H., Bradley, M.M., Berg, W.K., Cuthbert, B.N., & Lang, P.J. (2001). Emotional reactions in children: Verbal, physiological, and behavioral responses to affective pictures. *Psychophysiology, 38*, 222-231.

Mermelstein, R., Hedeker, D., & Weinstein, S. (2010). Ecological momentary assessment of mood-smoking relationships in adolescent smokers. In J.D. Kassel (Ed.),

Substance use and emotion (pp. 217-236). Washington, D.C.: American Psychological Association.

Mueller, V., Mucha, R.F., & Pauli, P. (1998). Dependence on smoking and the acoustic startle response in healthy smokers. *Pharmacology Biochemistry and Behavior, 59*, 1031 – 1038.

Nesbitt, P.D. (1973). Smoking, physiological arousal, and emotional response. *Journal of Personality and Social Psychology, 25*, 137-144.

Nichter, M., Nichter, M., Vuckovic, N., Quintero, G., & Ritenbaugh, C. (1997). Smoking experimentation and initiation among adolescent girls: Qualitative and quantitative findings. *Tobacco Control, 6*, 285-295.

Öhman, A., Hamm, A., & Hugdahl, K. (2000). Cognition and the autonomic nervous system: Orienting, anticipation, and conditioning. In J.T. Cacioppo, L.G. Tassinary, G.G. Berntson (Eds.), *Handbook of psychophysiology* (2nd Edition, pp. 533-575). New York: Cambridge University Press.

Parrott, A.C. (1999). Does cigarette smoking cause stress? *American Psychologist, 54*, 817-820.

Perkins, K.A., Jetton, C., & Keenan, J. (2003). Common factors across acute subjective effects of nicotine. *Nicotine & Tobacco Research, 5*, 869-875.

Piasecki, T.M., & Baker, T.B. (2000). Does smoking amortize negative affect? *American Psychologist, 55*, 1156-1157.

Piper, M.E., & Curtin, J.J. (2006). Tobacco withdrawal and negative affect: An analysis of initial emotional response intensity and voluntary emotion regulation. *Journal of Abnormal Psychology, 115*, 96 – 102.

Prokhorov, A.V., Koehly, L.M, Pallonen, U.E., & Hudmon, K.S. (1998). Adolescent nicotine dependence measured by the Modified Fagerstrom Tolerance Questionnaire at two time points. *Journal of Child & Adolescent Substance Abuse, 7*, 35-47.

Prokhorov, A.V., Pallonen, U.E., Fava, J.L., Ding, L., & Niaura, R. (1996). Measuring nicotine dependence among high-risk adolescent smokers. *Addictive Behaviors*, *21*, 117–127.

Schmid, A., Koch, M., & Schnitzler, H.U. (1995). Conditioned pleasure attenuates the startle response in rats. *Neurobiology of Learning and Memory, 64*, 1-3.

Shiffman, A., & Jarvik, M.E. (1984). Cigarette smoking, physiological arousal, and emotional response: Nesbitt's paradox re-examined. *Addictive Behaviors, 9*, 95-98.

Siqueira, L., Diab, M., Bodian, C., & Rolnitzky, L. (2000). Adolescents becoming smokers: The roles of stress and coping methods. *Journal of Adolescent Health, 27*, 399-408.

Stritzke, W. G. K., Patrick, C. J., & Lang, A. R. (1995). Alcohol and human emotion: A multidimensional analysis incorporating startle-probe methodology. *Journal of Abnormal Psychology, 104*, 114-122.

Vrana, S.R., Cuthbert, B.N., & Lang, P.J. (1989). Processing fearful and neutral sentences: Memory and heart rate change. *Cognition and Emotion, 3*, 179-195.

Vrana, S.R., Spence, E.L., & Lang, P.J. (1988). The startle probe response: A new measure of emotion? *Journal of Abnormal Psychology, 97*, 487-491.

Wills, T.A., Sandy, J.M., Yaeger, A.M. (2002). Stress and smoking in adolescence: A test of directional hypotheses. *Health Psychology, 21*, 122 – 130.

APPENDICES

APPENDIX A

INFORMED ASSENT AND PARENTAL CONSENT FORMS

University of Illinois at Chicago
Assent to Participate in Research
"PIECE BY PIECE: MAKING HEALTH CONNECTIONS"
Project 3: Smoking & Emotions

Leave box empty - For office use only
STARTS APPROVAL EXPIRES
NOV 18 2007 NOV 16 2008
UNIVERSITY OF ILLINOIS AT CHICAGO
INSTITUTIONAL REVIEW BOARD

We are asking you to take part in a research study conducted by Dr. Jon Kassel, a professor in the Department of Psychology at the University of Illinois at Chicago. You are being asked because you are involved in the "Piece by Piece: Making Health Connections" study. We ask that you read this form and ask any questions you may have before agreeing to be in the research. Because you are under 18 years of age, you will need your parents' permission in order to participate.

You decide if you want to participate in this research. If you don't want to be in this study, you don't have to be involved. Remember, being in this study is up to you and no one will be upset if you don't want to participate or even if you change your mind later and want to stop.

Why is this research being done?
We are trying to learn more about the physical and emotional effects that cigarette smoking has on adolescents, and to see if there are differences between smoking and nonsmoking adolescents. To do this, the study will include both students who have and those who have not tried smoking cigarettes. Approximately 230 teenagers (both smokers and nonsmokers) may be involved in this research.

What is are involved?
If you agree to be in this research, we will ask you to attend three separate sessions (this session now, one 6 weeks from now, and one 2 years from now). Each session will last about 1½ hours. During the session, you will be asked to fill out a short questionnaire about your experiences with cigarette smoking and your current mood. Then you will have small sensors (electrodes) placed on your arms and face in order to measure several bodily processes (for example, your heart rate) throughout the session. Placement of the sensors will take several minutes, but is not at all painful. At several points in the study, we will also ask you to blow through a tube in order to measure the level of carbon monoxide in your lungs (nonsmokers will only do this once). You will also be asked to fill out another questionnaire about how you feel right at that moment.

If you are a smoker, you will be given the opportunity to smoke one of our tobacco cigarettes; you may smoke as much or as little of the cigarette as you choose. You do not have to smoke this cigarette if you do not want to. All participants then view a series of slides, some of which are pleasant (for example, laughing babies) and others of which are unpleasant (for example, a snake). While you are viewing these slides, you will occasionally hear a loud tone presented over headphones. We ask that you simply ignore these tones and continue viewing the slides. Once you have viewed all of the slides, the study will be over and we will explain this research in more detail to you.

What are the potential risks and discomforts?
There are some potential risks from participating in this study. Some individuals may find some of the slides to be unpleasant. However, each slide is viewed for only seconds and these slides have been viewed in many studies with hundreds of participants with no reported bad effects. In addition, the loud tone presented over the headphones may be uncomfortable; however, other studies have used a similar loud tone without any reported bad effects.

Are there benefits to taking part in the research?
There are no direct benefits to you; however, the potential benefits to society are great because this study will help us better understand the effects that smoking has on adolescent smokers and create better smoking prevention and cessation programs for future high school students.

What about privacy and confidentiality?
The only people who will know that you are involved in this research are members of the "Piece by Piece: Making Health Connections" research team. No information about you, or provided by you during this research, will be shared with anyone else without your written permission, except if you are injured and need emergency care or when the UIC Institutional Review Board monitors the research or consent process.

To protect your privacy, we do not use your name on any of the information you provide to us. Your questionnaires and laboratory data will have a project ID number listed instead of your name. The only people who can match your name to your ID are members of our research team. All your information will be kept strictly confidential. This information will be kept in locked files and only authorized project staff will have access to it. The data that you provide will be kept for 10 years and then destroyed.

What are the costs for participating in this research?
There are no costs to you for participating in this research study. You will be paid for participating in the study. You will be paid $45 at the end of the first and second laboratory visit and $60 after completing the final session. Therefore, if you complete all parts of this project, you will receive a total of $150.

Can I stop participating in the study?
You can choose whether to be in this study or not. If you volunteer to be in this study and later change your mind, you can stop and no one will be upset. You may also refuse to answer any questions you don't want to answer and still remain in the study. The investigator may also end your participation in the study if there are reasons for doing so.

Who should I contact if I have questions?
The researcher conducting this study is Dr. Jon D. Kassel; you may contact him at (312) 413-9162. You can also call the toll-free Health Connections hotline with any questions at (866) 413-8824. If you have any questions about your rights as a research subject, you may call the UIC Office for Protection of Research Subjects at (312) 996-1711. You will be given a copy of this form for your records.

Signature
Signing your name on this form means that you agree to be in this study. You will also need your parents permission before you can participate.

_____ _____
Signature Date

_____
Printed Name

_____ _____
Signature of Researcher Date (must be same as subject's)

University of Illinois at Chicago
Parental Permission for Participation in Research
"PIECE BY PIECE: MAKING HEALTH CONNECTIONS"
Project 3: Smoking & Emotions

Why is your son/daughter being asked to participate?
Your son/daughter is being asked to be a subject in a research study about the effects of cigarette smoking on certain physical responses, like heart rate, that people often have when viewing different kinds of pleasant and unpleasant pictures. This study is being conducted by Dr. Jon Kassel, Department of Psychology, at the University of Illinois at Chicago. Your son/daughter has been asked to participate in the research because they are involved in the "Piece by Piece: Making Health Connections" study. We ask that you read this form and ask any questions you may have before allowing your son/daughter to be in the research.

Your child's participation in this research is voluntary. Their decision whether or not to participate will not affect their current or future relations with the University. If they decide to participate with your permission, they are free to withdraw at any time without affecting those relationships.

Why is this research being done?
Most of the previous research on cigarette smoking has used adult smokers. Far less research, however, has been done with adolescents like your son/daughter. Therefore, this study is being conducted both to better understand some of the effects that cigarette smoking has on adolescents, as well as to see if there are differences between smoking and nonsmoking adolescents. There are few, if any, risks associated with participation in this study.

Summary
The primary purpose of this study is to better understand the effects of smoking on physical and emotional responses to viewing pictures and to see if there are differences in responses between smokers and nonsmokers. Such research is important because it can help us more clearly understand some of the rewarding effects that smoking has on adolescent smokers. Approximately 230 subjects, both smokers and nonsmokers, will participate in this study.

What procedures are involved?
If your son/daughter agrees to be in this research, we would ask him/her to do the following things:

This study involves attending three separate sessions, each lasting about 1½ hours, over a 2-year period. The first two visits will occur 6-weeks apart; the final visit will be 24-months after the first visit. Upon arrival at the experimental session, your child will be asked to fill out several questionnaires asking about their experiences with cigarette smoking and their current mood. Then they will have small sensors (electrodes) placed on their arms and face in order to measure several bodily processes (for example, heart rate) throughout the session. The sensors actually measure electrical currents in the body. Placement of the sensors will take several minutes, but is not at all painful. At several points in the study, we will also ask

them to blow through a tube in order to measure carbon monoxide, which is a by-product of cigarette smoke. (Nonsmokers will only do this once). They will also be asked to fill out a questionnaire at several points in time which asks them about how they are feeling right at that moment.

If your son/daughter is a smoker, they will be given the opportunity to smoke one of our research tobacco cigarettes; they may smoke as much or as little of the cigarette as they choose. He/She does not have to smoke at all if he/she does not want to. All participants will then view a series of slides, some of which are pleasant (for example, laughing babies) and others of which are unpleasant (for example, a snake). While they are viewing these slides, they will occasionally hear a loud tone presented over headphones. We ask that they simply ignore these tones and continue viewing the slides. Once they have viewed all of the slides, the study will be over and we will explain this research in slightly more detail at that point in time.

What are the potential risks and discomforts?
Participation in this study has minimal risk. Although some of the slides are unpleasant, they are viewed for only several seconds and this procedure has been used in many studies with no reported bad effects.

Are there benefits to taking part in the research?
Although your son/daughter will not receive any direct benefits, the potential benefits to science and society are great because this study will help us better understand the effects that smoking has on adolescent smokers.

What about privacy and confidentiality?
The only people who will know that your teenager is a research subject are members of the research team. No information about your son/daughter will be disclosed to others without your written permission, except:

- if necessary to protect your child's rights or welfare (for example, if your son/daughter is injured and needs emergency care, or when the UIC Institutional Review Board monitors the research or consent process); or
- if required by law.

When the results of the research are published or discussed in conferences, no information will be included that would reveal your child's identity. Any information that is obtained in connection with this study and that can be identified with your child will remain confidential and will be disclosed only with your permission or as required by law.

Any information about your son/daughter obtained from this research, including answers to questionnaires and laboratory data, will be kept strictly confidential. Information will be kept in locked files and only the principal investigator and his research assistants will have access to it. The data provided by your child will be kept for 10 years and then destroyed.

What are the costs for participating in this research?
There are no costs to you or your child for participating in this research study.

Will your son/daughter be reimbursed for expenses or paid for participating in this research?
Your son/daughter will be paid for participating in the study. He/She will be paid $45 at the end of the first and second laboratory visit and $60 after completing the final session. Therefore, if your child completes all parts of this project, he/she will receive a total of $150.

Can your son/daughter withdraw or be removed from the study?
With your permission, your child can choose whether to be in this study or not. If your son/daughter volunteers to be in this study, he/she may withdraw at any time without consequences of any kind. Your

child may also refuse to answer any questions they don't want to answer and still remain in the study. The investigator may withdraw your son/daughter from this research if circumstances arise which warrant doing so (like belligerent behavior or noncompliance).

Who should you contact with questions?
The researcher conducting this study is Dr. Jon D. Kassel; you may contact him at (312) 413-9162. You can also call the toll-free Health Connections hotline with any questions at (866) 413-8824.

What are your son's/daughter's rights as a research subject?
If you have any questions about your child's rights as a research subject, you may call the Office for Protection of Research Subjects at (312) 996-1711. You will be given a copy of this form for your information and to keep for your records.

Signature of Parent(s)
As the legal parent of the minor, _____, I state that I am _____ years of age and permit my teenager to participate in a research study being conducted by Dr. Jon D. Kassel from the Department of Psychology. I understand that while the study will be under the supervision of this individual, other professionals who work with him may assist or act on his behalf. I have read (or someone has read to me) the above information. I have been given an opportunity to ask questions and my questions have been answered to my satisfaction. I consent for my son/daughter to participate in this research. I will be provided a copy of this form.

_____	_____
Parent/Guardian (Sign and Date)	(Print name)
_____	_____
Teenager participant (Sign and Date)	(Print name)
_____	_____
Signature of Researcher	Date (must be same as subject's)
_____	_____
Signature of Witness (if appropriate)	Date (must be same as subject's)

_____
Printed name of Witness (if appropriate)

APPENDIX B

MODIFIED FAGERSTROM TOLERANCE QUESTIONNAIRE (MFTQ) ITEMS

1) How many cigarettes a day do you smoke, on average?
2) Do you inhale?
3) How soon after you wake up do you smoke your first cigarette?
4) Which cigarette would you hate to give up?
5) Do you find it difficult to refrain from smoking in places where it is forbidden (church, library, movies, etc.)?
6) Do you smoke if you are so ill that you are in bed most of the day?
7) Do you smoke more during the first 2 hours of the day than during the rest of the day?

APPENDIX C

SMOKING QUESTIONNAIRE

1. Please think about your smoking (even a puff) during THE LAST 7 DAYS.

Please fill in the following table. If you did not smoke on a day, enter '0'. If you smoked (even a puff), but less than 1 cigarette, enter '1'.

DURING THE LAST 7 DAYS YOU SMOKED…	Today	Yesterday	2 days ago	3 days ago	4 days ago	5 days ago	6 days ago
FIRST: please write in the days of the week.							
About how many cigarettes did you smoke on each of these days? (Write in the number of cigarettes smoked on each day.)							

2. Now think about the past 30 days. On how many days did you smoke or try cigarettes? (Circle the one response that best describes you).

(1) 0 days
(2) 1 day
(3) 2 to 3 days
(4) 4 to 5 days
(5) 6 to 7 days
(6) 8 to 10 days
(7) 11 to 20 days
(8) 21 to 29 days
(9) All 30 days

3. Think about the past 30 days. On the days you smoked cigarettes, about how many cigarettes did you smoke each day? (Circle the one response that best describes you).

(1) I did not smoke cigarettes during the past 30 days
(2) Less than one cigarette per day
(3) 1 cigarette per day
(4) 2 cigarettes per day
(5) 3 cigarettes per day
(6) 4 cigarettes per day
(7) 5 cigarettes per day
(8) 6 to 10 cigarettes per day
(9) 11 to 19 cigarettes per day
(10) 20 cigarettes per day (one pack)

(11) More than 20 cigarettes per day

4. About how many cigarettes have you smoked in your entire life?

(1) 500 or more
(2) 100 or more cigarettes (5 or more packs)
(3) 26 to 99 cigarettes (more than one pack, but less than 5 packs)
(4) 16 to 25 cigarettes (about 1 pack total)
(5) 6 to 15 cigarettes (about ½ pack total)
(6) 2 to 5 cigarettes
(7) 1 cigarette
(8) 1 or more puffs, but never a whole cigarette
(9) I have never smoked

5. Have you ever smoked cigarettes on a daily basis? (At least 30 days when you smoked every day or nearly every day)

(1) Yes (2) No

6. When was the last time you smoked a cigarette, even a puff?

(1) In the last 24 hours
(2) Not in the last 24 hours, but sometime during the past 7 days
(3) Not during the past 7 days, but sometime during the past 14 days
(4) Not during the past 14 days, but sometime during the past 30 days
(5) Not during the past 30 days, but sometime during the past 6 months
(6) Not during the past 6 months, but sometime during the past year
(7) 1 to 4 years ago
(8) 5 or more years ago
(9) I have never smoked

7. Have you smoked a cigarette at all (even a puff) since your last visit to our lab?**

(1) Yes
(2) No

8. Are you ***seriously*** trying to quit smoking in the next 2 weeks?

(1) No
(2) Yes

**Note: This item was given at Visit 2 only.

ORIGINAL INSTITUTIONAL REVIEW BOARD (IRB) APPROVAL FOR PROGRAM PROJECT

UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

Approval Notice
Initial Review (Response To Modifications)

January 4, 2005

Robin J. Mermelstein, PhD
Psychology
1747 W Roosevelt
Rm 558, M/C 275
Chicago, IL 60612
Phone: (312) 996-1469 / Fax: (312) 413-4122

RE: Protocol # 2004-0621
"Social-Emotional Contexts of Adolescent Smoking - Longitudinal Study"

Dear Dr. Mermelstein:

Your Initial Review (Response To Modifications) was reviewed and approved by IRB #2 by the Expedited review process on December 16, 2004. You may now begin your research.

Please note the following information about your approved research protocol:

Protocol Approval Period:	December 16, 2004 - November 17, 2005
Approved Subject Enrollment #:	2800
Performance Sites:	UIC, University of Chicago
Sponsor:	NCI - National Cancer Institute

Research Protocol:

a) Social-Emotional Contexts of Adolescent Smoking - Longitudinal Study

Recruitment Materials:

a) Project 2: Family Talk-Home Visit Script Version 2 10/22/2004
b) Enrollment Script Parent Health Habits Version 3 12/07/2004
c) Enrollment Script Student Health Habits Version 3 12/07/2004

d) Invitation Letter Version 3 12/07/2004

e) "Piece by Piece" Making Health Connections (Research Project Fact Sheet) Pamphlet (No V#, No Date)

Informed Consents:

a) Project 2 Family Talk Parental Consent Version 2 10/22/2004

b) Consent Parent Questionnaire Version 2 10/22/2004

Assents:

a) Project 2 Family Talk Teen Assent Version 2 10/22/2004

b) Assent Electronic Diary Version 2 10/22/2004

c) Assent Project 3 Smoking & Emotions Version 3 12/07/2004

d) Assent Health Habits Version 3 12/07/2004

Parental Permissions:

a) Project 3 Parental Permission Smoking & Emotions Version 3 12/07/2004

b) Parental Permission Electronic Diary Version 3 12/07/2004

c) Parental Permission Health Habits Version 3 12/07/2004

Other Document:

a) Project 3: Smoking & Emotions Debriefing Script Version 2 10/22/2004

Please note the Review History of this submission:

Receipt Date	Submission Type	Review Process	Review Date	Review Action
09/08/2004	Initial Review	Convened	09/23/2004	Deferred
11/03/2004	Response To Deferred	Convened	11/18/2004	Modifications Required
12/13/2004	Response To Modifications	Expedited	12/16/2004	Approved

Please remember to:

→ Use your **research protocol number** (2004-0621) on any documents or correspondence with the IRB concerning your research protocol.

→ Review and comply with all requirements on the enclosure,
"**UIC Investigator Responsibilities, Protection of Human Research Subjects**"

Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 355-2939. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Jewell Hamilton, MSW
IRB Coordinator, IRB # 2
Office for the Protection of Research Subjects

Enclosures:

1. **UIC Investigator Responsibilities, Protection of Human Research Subjects**
2. **Informed Consent Documents:**

a) Project 2 Family Talk Parental Consent Version 2 10/22/2004
b) Consent Parent Questionnaire Version 2 10/22/2004

3. **Assent Documents:**

a) Project 2 Family Talk Teen Assent Version 2 10/22/2004
b) Assent Electronic Diary Version 2 10/22/2004
c) Assent Project 3 Smoking & Emotions Version 3 12/07/2004
d) Assent Health Habits Version 3 12/07/2004

4. **Parental Permissions:**
   a) Project 3 Parental Permission Smoking & Emotions Version 3 12/07/2004
   b) Parental Permission Electronic Diary Version 3 12/07/2004
   c) Parental Permission Health Habits Version 3 12/07/2004
5. **Recruiting Materials:**
   a) Project 2: Family Talk-Home Visit Script Version 2 10/22/2004
   b) Enrollment Script Parent Health Habits Version 3 12/07/2004
   c) Enrollment Script Student Health Habits Version 3 12/07/2004
   d) Invitation Letter Version 3 12/07/2004
   e) "Piece by Piece" Making Health Connections (Research Project Fact Sheet) Pamphlet (No V#, No Date)
6. **Other Document:**

a) Project 3: Smoking & Emotions Debriefing Script Version 2 10/22/2004

7. **Form 310 - Protection of Human Subjects, Assurance Identification/Certification/Declaration**

cc: Gary E. Raney, Ph.D., Chairperson, Department of Psychology, M/C 285

CURRICULUM VITAE

Megan Conrad

1007 W. Harrison
MC 285
Chicago, IL 60607
Phone: (773) 888-3590
Email: mconrad@uic.edu

EDUCATION

Master of the Arts **2009-2011**
Major: clinical psychology
University of Illinois, Chicago, IL
Thesis: "Stability of Emotional Response in Adolescent Smokers and Nonsmokers: A Longitudinal Analysis"

Bachelor of Science **2003-2006**
Majors: psychology and Spanish

University of Illinois, Urbana-Champaign, IL

HONORS AND AWARDS

University Honors/Bronze Tablet Scholar **2006**
University of Illinois at Urbana-Champaign

Member of Phi Beta Kappa Honor Society **2006**
Gamma Chapter of the University of Illinois

James Scholar in the College of Liberal Arts and Sciences **2003-2006**
University of Illinois at Urbana-Champaign

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS

Student Affiliate **2010-present**
American Psychological Association

Member **2010-present**
American Psychological Association of Graduate Students

Graduate Student Affiliate **2010-present**
Association for Psychological Science

PEER-REVIEWED PUBLICATIONS

Conrad M, McNamara P, King A. (In preparation, 2011). Beverage blinding and acute responses to oral alcohol consumption.

Wardle MC, **Conrad M**, King A, de Wit H. (Submitted, 2011). Prediction of early smoking and smoking progression by individual differences in stress. *Nicotine & Tobacco Research*.

Veilleux JC, Kassel JD, Heinz AJ, Braun A, Wardle MC, Greenstein J, Evatt DP, **Conrad M**. (2011). Predictors and sequelae of smoking topography over the course of a single cigarette in adolescent light smokers. Journal of Adolescent Health, 48, 176-181.

Hamidovic A, Childs E, **Conrad M**, King A, de Wit H. (2010). Stress-induced cortisol release predicts mood responses to amphetamine. *Drug and Alcohol Dependence*, 109, 175-180.

King AC, McNamara PJ, **Conrad MF**, Cao D. (2009). Alcohol-induced increases in smoking topography for nicotinized and denicotinized cigarettes in men and women. *Psychopharmacology, 207*, 107-117.

King AC, Epstein A, **Conrad M**, McNamara P, Cao D. (2008). Sex differences in the relationship between alcohol-associated smoking urge and behavior: A pilot study. *American Journal on Addictions, 17*, 347-353.

BOOK CHAPTERS

Kassel JD, Veilleux JC, Heinz AJ, Braun AR, **Conrad M**. (In press, 2011). Emotion and Addictive Processes. In P. Miller (Ed.), *Encyclopedia of Addictive Behaviors*.

Winters KC, Chung T, Stinchfield RD, Kassel JD, **Conrad M**. (In press, 2011). Addictions and Adolescence. In *Encyclopedia of Human Behavior (2nd Edition)*. London: Elsevier.

PUBLISHED ABSTRACTS

Conrad MF, McNamara PJ, King AC. (2009). Effects of blinding procedures on perceived beverage content and subjective alcohol response. *Alcoholism: Clinical and Experimental Research, 33 (suppl),* 176A.

PRESENTATIONS AT SCIENTIFIC MEETINGS

Conrad MF, Kassel JD, Veilleux JC, Heinz AJ, Braun AR, Roesch L. (2010). Stability of emotional response in adolescent smokers and nonsmokers: A longitudinal analysis. *Poster presented at the 44th Annual Meeting of the Association for Behavioral and Cognitive Therapy, San Francisco, CA.*

Veilleux JC, **Conrad M**, Heinz A J, Kassel JD. (2010). Dynamic emotional responses underlying cigarette craving. *Poster presented at the 44th Annual Meeting of the Association for Behavioral and Cognitive Therapy, San Francisco, CA.*

Hamidovic A, Childs E, Conrad M, King A, de Wit H. (2010). Stress-induced changes in mood and cortisol release predict stimulant effect of amphetamine. *Poster presented at the 72nd Annual Meeting of The College on Problems of Drug Dependence, Scottsdale, AZ.*

Heinz AJ, Kassel JD, Veilleux JC, Braun A, **Conrad M**, Greenstein J, Evatt D, Wardle M, Roesch L, Mermelstein R. (2010). The acute effects of cigarette smoking on negative affect moderates nicotine dependence over time in adolescents. *Paper presented at the 16th Annual Scientific*

Sessions of the Society for Research on Nicotine and Tobacco, Baltimore, MD.

Veilleux JC, Kassel JD, Heinz AJ, Roesch L, Braun AR, **Conrad M**, Greenstein JE, Wardle MC, Evatt DP. (2010). Puffing behavior across a single cigarette for light adolescent smokers is influenced by nicotine dependence, depression, and anxiety. *Poster presented at the 16th Annual Scientific Sessions of the Society for Research on Nicotine and Tobacco, Baltimore, MD.*

Conrad MF, McNamara PJ, King AC. (2009). Effects of blinding procedures on perceived beverage content and subjective alcohol response. *Paper presented at the 32nd Annual Conference of the Research Society on Alcoholism, San Diego, CA.*

McNamara PJ, **Conrad MF**, Cao D, King AC. (2008). Sex differences in alcohol-induced increases in smoking topography for nicotinized and denicotinized cigarettes. *Paper presented at the 14th Annual Scientific Sessions of the Society for Research on Nicotine and Tobacco, Portland, OR.*

RESEARCH EXPERIENCE

Data Management Consultant **2011-present**
Culturally Targeted and Individually Tailored Smoking Cessation Study: LGBT Smokers, Phase 2 (NIDA)
PI: Alicia Matthews, PhD; Co-I: Andrea King, PhD; Co-I: Lisa Kuhns, PhD, MPH
Howard Brown Health Center, Chicago, IL

Culturally Targeted Smoking Cessation for HIV-positive Men who Have Sex with Men (University of Chicago)
PI: Alicia Matthews, PhD
Howard Brown Health Center, Chicago, IL

Text Messaging Intervention to Improve ART Adherence among HIV-Positive Youth (NIH)
PI: Rob Garofalo, MD, MPH; Co-I: Lisa Kuhns, PhD, MPH
Howard Brown Health Center, Chicago, IL

Follow-Up Coordinator **2007-2009**
Human Behavioral Pharmacology Laboratory
Director: Harriet de Wit, PhD
University of Chicago, Department of Psychiatry and Behavioral Neuroscience

Research Assistant **2006-2009**
Clinical Addictions Research Laboratory
Director: Andrea King, PhD
University of Chicago, Department of Psychiatry and Behavioral Neuroscience

Undergraduate Research Assistant **Dec-Jan 2005**
Cognitive Neuroscience Laboratory
Director: Neal Cohen, PhD
University of Illinois at Urbana-Champaign, Department of Psychology

CLINICAL EXPERIENCE

Clinician **2009-present**
Office of Applied Psychological Services
University of Illinois at Chicago

TEACHING EXPERIENCE

Graduate Teaching Assistant **Jan-May 2010**
Introduction to Research Methods in Psychology
Instructor: Benjamin Storm, PhD
University of Illinois at Chicago

Introduction to Research Methods in Psychology **Aug-Dec 2009**
Instructor: Jennifer Veilleux, MA
University of Illinois at Chicago

GUEST LECTURES

"Ethical Perspectives on Deception Research" **April 2011**
Ethics and Professional Development
Instructor: Sheela Raja, PhD
University of Illinois at Chicago

"Design Issues in Alcohol Research" **April 2010**
Introduction to Research Methods in Psychology
Instructor: Benjamin Storm, PhD
University of Illinois at Chicago

"Negative Affect, Coping, and Drinking Behavior and Motives in College Students" **April 2010**
Multivariate Analysis
Instructor: Thomas Griffin, PhD
University of Illinois at Chicago

"Alcohol Response and Problem Drinking" **March 2010**
Developmental Psychopathology
Instructor: Ellen Herbener, PhD
University of Illinois at Chicago

MENTORSHIP

Undergraduate Research Assistants
Joanna Singer, 2010-present
Dua Aburuman, 2010-present
Melanie Kleiter, Aug-Dec, 2010
Todd Lilje, 2010-present
Franchesca Garza, Jan-May 2010