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A Tobacco Consumption Diary To Assess The Factors Associated With Smoking In A Light Smoking College Population

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ABSTRACT

Limited information exists about the proximal predictors of light smoking fewer than 10 cigarettes per day (cpd). Furthermore, light smokers are not highly motivated to quit smoking. This study examined predictors of light smoking and motivational change toward quitting smoking in 118 light smoking college students. Participants completed a 7 day Tobacco Consumption Diary (TCD) by recording for each cigarette: time and day, location, number of people present, number of smokers present, mood, and whether alcohol was consumed. Carbon Monoxide (CO) feedback was also provided to a random half of the participants at the outset of the study. CO feedback and self-monitoring of 7 days of smoking were examined as to their influence on motivational changes toward quitting smoking. Results indicated limited motivation change as a function of CO feedback and self-monitoring. Behaviorally, light smoking appeared to be most strongly associated with the presence of alcohol, later time of day, and a variety of locations. Light smokers appear to be cue oriented in their smoking similar to heavier smokers, though motivating light smokers to quit through health feedback and self-monitoring activities is likely not effective.

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INTRODUCTION

1.1 Trends in Cigarette Smoking

Cigarette smoking is the leading cause of preventable death and disease (Centers for Disease Control and Prevention [CDC], 2005a), with an estimated 438,000 premature deaths annually in the U.S. (CDC, 2005b). One age group which may be particularly at risk for premature death due to smoking are young adults; those between the ages of 18 and 25 exhibit the highest rates of tobacco use in comparison to other age groups (Substance Abuse and Mental Health Services Administration [SAMHSA], 2004). Moreover, this phenomenon shows little sign of dissipation (Moran, Wechsler, & Rigotti, 2004), and while young adult smokers tend not to smoke as heavily as older individuals (Wetter et al., 2004), this may not attenuate the risk for health consequences young adults face such as lung cancer (Bjartveit & Tverdal, 2005; National Cancer Institute, 1998), myocardial infarction (Prescott, Scharling, Osler, & Schnohr, 2002) and cardiovascular mortality (Luota, Uutela, & Puska, 2000; Prescott et al., 2002). Furthermore, many young adults who smoke more lightly go on to smoke more regularly (Holmen, Barrett-Connor, Holmen, & Bjermer, 2000; Kenford et al., 2005; McCarthy, Zhou, & Yih-Ing, 2001; Russell, 1990; Wetter et al., 2004). As such, light smokers warrant attention in the tobacco control realm (Fiore et al., 2008).

Influences to Light Smoking. Broadly, some of the most salient factors that affect college student smoking, and thereby young adults, are the lack of signs of addiction, social smoking and drinking situations, and stress (Lenz, 2004). Presson, Chassin, and Sherman (2002) note similar factors, though they suggest that light smokers' motivations to smoke are strongly based on misconceptions about the addictiveness of nicotine, lower conscientiousness about smoking behavior, higher extraversion, less life satisfaction, and lower positive affect.

Craving and Addiction. The urge to smoke may be considerably less in lighter smokers compared with heavier smokers (Sargent, Mott, & Stevens, 1998; Shiffman & Paty, 2006; Shiffman, Paty, Gnys, Kassel, & Elash, 1995; Sayette et al., 2001). Light smokers also exhibit less tolerance (Soresi, Catalano, Spatafora, Bonsignore, & Bellia, 2005) and fewer symptoms of withdrawal compared to heavier smokers (Shiffman, Paty, Kassel, Gnys, & Zettler-Segal, 1994). Nevertheless, Wellman, DiFranza, and Wood (2006) report that despite not warranting a diagnosis of nicotine dependence, a large percentage of light smokers (77%) report not having full autonomy over when they decide to smoke. Other factors are more likely to contribute to light smoking than nicotine dependence and tolerance.

Affect and Mood. Smoking urges are strongly associated with mood, negative affect, and anxiety in adults (Aronson, Almeida, Stawski, Klein, & Kozlowski, 2008; Delfino, Jammer, & Whalen, 2001). While light smokers' affective states appear to be less influenced by cigarette smoking relative to heavier smokers (Sayette, Martin, Wertz, Shiffman, & Perrott, 2001), negative affect (Hoz et al., 2004), depressive symptoms (Patton et al., 1996; Zhu, Sun, Billings, Choi, & Malarcher, 1999) as well as anxiety (Patton et al., 1996) do appear to influence adolescents' and young adults' smoking patterns. Relative to heavier smokers, light smokers may also smoke more as an indulgent activity (Shiffman & Paty, 2006) or when their moods are higher (Shiffman et al., 1994). It is therefore not entirely clear what influence the internal cue of mood has on light smoking over the course of a given day, especially when considered in the context of other influences to light smoking.

At-Risk Times and Places for Light Smoking. Light smokers appear to be particularly susceptible to smoking during the weekend (Colder et al., 2006; Murphy-Hoefer, Alder, & Higbee, 2004), when going out to bars and restaurants (Shiffman & Paty, 2006), and when

relaxing (Shiffman & Paty, 2006; Shiffman et al., 1994). More relaxed situations may thereby provide relevant cues to light smokers. In addition, light smokers tend to smoke more after 5pm at night (Krukowski, Solomon, & Naud, 2005; Shiffman & Paty, 2006). In line with this observation, light smokers tend to report that instead of the first cigarette of the day being the most difficult to give up (as is often the case with heavier smokers), the last cigarette of the day is often reported to be most difficult to give up (Shiffman et al., 1994). Nighttime smoking may thereby be the most probable at-risk time for light smokers to desire to smoke.

Light smokers also appear to react strongly to conditioned environmental cues to smoke (Lazev, Herzog, & Brandon, 1999), even when very subtle (Sayette, Martin, Wertz, Perrott, & Peters, 2005). Some of these cues may be social in nature, such as being near family members who smoke (Chandola, Head, & Bartley, 2004; Zhu et al., 1999) or other adolescent peers' (Patton et al., 1996) and young adult peers' smoking (Ridner, 2005; Morrell, Cohen, Bacchi, & West, 2005). This again suggests light smokers respond to more external cues to smoke.

Light Smoking and Alcohol Consumption. Specific to light smokers, consumption of alcohol influences smoking behavior (Krukowski et al., 2005; Shiffman & Paty, 2006). Even the mere presence of alcohol appears to trigger cravings in nicotine deprived smokers, and actual alcohol intoxication amplifies these cravings to smoke (Lazev et al., 1999; Sayette et al., 2005; Sayette, 2002). At the same time, nicotine administration in conjunction with alcohol administration in humans can increase the sedative effects of alcohol (Acheson, Mahler, Chi, & de Wit, 2006) which suggests that smoking in conjunction with alcohol use may relax light smokers more than what would be expected with alcohol intake alone. In addition, reasonable evidence exists to suggest a dose-dependent link between amount smoked and amount drunk

(Dierker et al., 2006). Overall, alcohol consumption and light smoking appear to be strongly intertwined behaviors which may "complement" each other for light smokers.

In college students, consideration of alcohol consumption in the context of light smoking is an especially pertinent consideration as upwards of 80% of young adults report at least some degree of alcohol consumption (Johnston, O'Malley, Bachman, & Schulenberg, 2004). Many college students in particular may overestimate the amount their peers are drinking (Broadwater, Curtin, Martz, & Zrull, 2006). To the extent that these overestimations of peers' drinking occurs, the influence of perceived alcohol consumption norms may actually serve to exacerbate the amount smoked in college students given the strong link between alcohol and light smoking.

1.2 Assessment of Light Smoking Behavior in Diary Format

One useful and often utilized method of assessment of health behaviors is a recording diary (Bolger, Davis, & Rafaeli, 2003). Drinking behaviors and patterns in relation to situations and places (e.g., Armeli, Todd, & Mohr, 2005; Collins, Kashdan, & Gollnisch, 2003; Engels, Wiers, Lemmers, & Overbeek, 2005; Gmel & Rehm, 2004; Heeb & Gmel, 2005; Morawska & Oei, 2005; Todd, Armeli, Tennen, Carney, & Affleck, 2003), dietary intake in relation to situations and places (cf., de Castro, 2000; de Castro, 1991, de Castro & de Castro, 1989), and smoking in relation to health consequences, situations, and places (e.g., Huang, 2005; Kaiser et al., 1998; Shapiro, Jamner, Davydov, & James, 2002; Thomsson, 1997; Whalen, Jamner, Henker, & Delfino, 2001).

Assuming a cigarette takes approximately 5 min. total to smoke, and 10 cigarettes are smoked in a day—as is the case for a general cutoff for light smoking—only 3.5% of a 24 hour period is spent smoking. Diary methods work well for recording rare events (Bolger et al., 2003; Moghaddam & Ferguson, 2007), such as in the case of light smoking. Indeed, Thomsson (1997)

found that the most diligent at keeping records in paper based diaries were light smokers (M = 7 cpd) with heavier smokers dropping out of the study. This suggests that light smokers may be amenable to paper based diary assessment of smoking. While some debate has taken place about the relative compliance with paper diaries (Bolger et al., 2003; Hufford, Stone, Shiffman, Schwartz, & Broderick, 2002; Stone, Shiffman, Schwartz, Broderick, & Hufford, 2003), the present study employed a small easily completed paper diary to track a rare event: light smoking. This small diary was designed to fold around a cigarette pack and into the cellophane (discussed in the Methods below).

1.3 Methodological Approach to Examining Change in Behavior

Consciousness raising and self-reevaluation are two cognitive behavioral constructs which may motivate individuals to change a health behavior (Pallonen, 1998; Schnoll et al., 2002). An example of consciousness raising might be gaining and understanding feedback about a risk behavior (e.g. Carbon Monoxide [CO] feedback to a smoker). Self-reevaluation entails value assessment related to risk behavior. In light smokers, self-reevaluation might come by means of greater awareness of both one's smoking habits (i.e., how much one actually smokes) and the discrepancy between one's ipsative perceptions of what comprises a smoker and whether or not s/he is, by that definition, a smoker.

In considering methodological approaches to increasing consciousness and self-reevaluation for those who may be relatively unmotivated to quit smoking, a tobacco consumption diary (TCD) may not only be useful in assessing light smoking behavior, but also may increase these individuals' awareness of their smoking. This approach aims to bring awareness of smoking behavior in a manner which approximates a common cognitive-behavioral strategy known as self-monitoring (Farmer & Chapman, 2008; Heidt & Marx, 2003). Self-

monitoring is considered any behavior that involves reflecting on one's behavioral, cognitive, or emotional state and providing self-reports of such behavior (Simpson, Kivlahan, Bush, & McFall, 2005).

Self-monitoring can sometimes be a useful technique in linking an intention to change a behavior (e.g., smoking) and actually changing that behavior (Sniehotta, Nagy, Scholz, & Schwarzer, 2006). Indeed, self-monitoring has been shown to be effective in helping individuals change a variety of behaviors including: drinking behaviors (Collins, Kashdan, & Gollnisch, 2003; Skutle & Berg, 1987), eating in a more healthy fashion (Nothwehr & Peterson, 2005), increasing physical activity (Carels et al., 2005; Conn, Valentine, & Cooper, 2002; Heesch, Mâsse, Dunn, Frankowski, & Mullen, 2003; Nothwehr & Peterson, 2005), losing weight (Carels et al., 2005; Simkin-Silverman et al., 1995), and increasing blood glucose monitoring in type 2 diabetics (Siebolds, Gaedeke, & Schwedes, 2006). Self-monitoring is also a standard cognitive behavioral technique which can be employed as part of treatment of a variety mental health disorders (Farmer & Chapman, 2008). Meta-analyses indicate a reasonable effect for self-monitoring as a component of interventions aimed at increasing physical activity (Conn et al., 2002), improving nutrition, decreasing alcohol consumption, and quitting smoking (Mullen et al., 1997).

Reactivity as a result of insight into one's personal smoking has been documented in the literature, though often indirectly (e.g., Joule, 1991; McFall, 1970). Notably, Etter (2004) noted a positive linear trend between the assessment of the risks of smoking and the amount individuals smoked; light smokers had the least amount of risk assessment (1 to 5 cpd). More notably, self-monitoring smoking diaries as a component of broader interventions for women increase quit rates between 10 and 25% in healthcare settings (Krummel et al., 2001). Hence, a smoking diary

targeting light smokers with lower motivation to quit may thus have an impact on increasing motivation to quit.

Further awareness and insight to personal smoking behavior may also come from information regarding one's exhaled carbon monoxide reading. A number of studies have indicated that self-expired CO feedback as a form of behavioral monitoring results in increased reactivity and decreased smoking (e.g., Abueg, Colletti, & Kopel, 1985; Becoña & García, 1993). It therefore seems likely that being provided with a CO reading as well as awareness building via a self-monitoring smoking diary may further increase motivation to quit smoking.

1.4 Theoretical Framework

Self-monitoring can be conceptualized, in part, as a technique to bring about awareness of behavior and behavior-attitude discrepancies. This conceptualization fits well within the Objective Self-Awareness Theory (OSAT) framework (Duval & Wicklund, 1972). OSAT has been shown to influence cognitive processing and resulting behavior (Geller & Shaver, 2005). However, OSAT has not generally been supported among heavier smokers (Liebling, Selier, & Shaver, 1974), though questions about the methodology (i.e., change in smoking behavior when smoking in front of a mirror) used by Liebling and colleagues limited the interpretations of their findings (Wicklund, 1975). However, no examination of OSAT has been applied to light smokers prior to this study. For light smokers, it may be that in the absence of the addiction and withdrawal symptoms typically associated with heavier smoking, the most salient influence on continued light smoking is a lack of awareness about personal smoking behavior. Bringing about awareness via more extensive self-monitoring may facilitate motivation to quit.

Cognitive Dissonance Theory (CDT) may also serve to explain why light smokers might negate they are actually smoking enough to incur harm (Festinger, 1957). Years before

consistent attention by the research community to moderate and light smokers began, Festinger's work in CDT assessed risk assessment in heavy, moderate, light, and non-smoking individuals, much the same way as smoking status is delineated in the current decade. Broadly, CDT posits a dissonance between one's behavior and perceptions about that behavior (Phillips & Silvia, 2005). In the case of intermittent and more like smoking college students, Koontz et al (2004) reported that fully 92% identified as non-smokers, yet 42% of this group still reported a desire to stop smoking sometime in the future. In essence, while desiring to quit, they did not consider themselves smokers. Rodriguez, Johnson, Venegas, and Cooper (2006) found support for cognitive dissonance in UTEP light smokers such that they did not typically self-identify as smokers despite consistently smoking. Hence, it may be that light smokers at UTEP are engaging in cognitive dissonance by considering themselves non-smokers so as to avoid consideration of the more negative consequences of smoking. In heavy smokers (*M* cpd = 27) who have quit and then relapsed, a similar interpretation can be made; after relapse some smokers increased cognitive dissonance regarding their smoking and the health risks associated with smoking (Gibbons, Eggleston, & Benthin, 1997). In addition, asking smokers to prepare materials that discuss risks of smoking and the feasibility of quitting decreased cognitive dissonance about their behavior and consideration of quitting (Simmons, Webb, & Brandon, 2004). A similar approach to this process entailed asking light smokers to record their smoking behavior to encourage awareness of this behavior in order to increase motivation to quit. In sum, OSAT may provide the basis for explaining the realization of discrepancy between self-perception and one's behaviors (e.g., smoking), while the discomfort experienced by the cognitive dissonance (CDT) provides a theoretical mechanism for how motivation to change smoking behaviors might occur.

The Transtheoretical Stages of Change Model (TTM) was employed to assess motivation to change smoking behavior within the context of OSAT and CDT. The TTM is a motivational staging algorithm comprised of 5 stages: a) precontemplation, b) contemplation, c) preparation d) action, and e) maintenance (DiClemente & Prochaska, 1982; Prochaska, DiClemente, & Norcross, 1992) which represents an integration of previous social and cognitive theory-based intervention components to assess behavior change in individuals (Prochaska, 2006). The effectiveness of the TTM is well supported in assessment of behavior change in general (Spencer, Pagell, Hallion, & Adams, 2002) and specifically, in changing motivation to quit smoking (e.g. Aveyard et al., 2006; Prochaska, Velicer, Prochaska, & Johnson, 2004; Spencer et al., 2002; Velicer, Prochaska, & Redding, 2006). Moreover, the TTM is an effective means of examining factors associated with light smokers (Etter, 2004) and college smokers (Stewart, 2001) as well as a reasonable means of tracking motivation to change in Hispanics (Harlow et al., 1999; Keller & McGowan, 2001; Suminski & Petosa, 2002; Surís, Trapp, DiClemente, & Cousins, 1998). Additionally, the TTM remains sensitive to motivation to change behavior even after brief interventions (McDaniel, Casper, Hutchison, & Stratton, 2005; Prochaska et al., 2004) and can be used to assess motivation to change even when a therapeutic intervention is not optimally matched with the stage of change an individual is in (Quinlan & McCaul, 2000).

Motivation may change as a function of small tasks such as self-monitoring and health feedback (e.g., CO feedback). In support of this notion, a brief intervention targeting low-income women which lasted an average of 13.9 minutes resulted in significant cognitive change related to the TTM as well as decreased favorable attitudes toward smoking (McDaniel et al., 2005). Furthermore, a meta-analysis of smoking interventions in work settings found that those interventions that were not overly complex in nature were more effective (Fisher, Glasgow, &

Terborg, 1990). Finally, Collins and colleagues (2003) found that social drinkers' self-monitoring of personal drinking was not difficult to complete, and Thomsson (1997) found that lighter smokers had better success in recording intake compared to heavier smokers; a smoking diary may represent a reasonable and inexpensive strategy by which to intervene with light smokers in a public health (i.e., collegiate) context.

1.5 Aims and Hypotheses of the Present Study

At UTEP, light smoking is a serious concern. Recent data indicate that UTEP smokers are predominantly light smoking in nature, though they may not necessarily identify as smokers (Rodriguez et al., 2006; Rodriguez, Redfearn, Johnson, Tajiri, & Cooper, 2005). As Rodriguez and colleagues (2006) found that light smokers at UTEP may not consider themselves smokers despite smoking, diary interventions were posited to be successful enough in bringing awareness of personal smoking and to result in a change along the TTM continuum toward quitting smoking.

Study Aims. The present study had two aims. First, given the possibility that light smokers are less aware of their smoking and the potential health effects of their smoking, this study examined whether furthering awareness of one's personal smoking via a tobacco consumption diary/record (TCD) is a technique substantial enough to produce contemplation of quitting smoking (i.e., a change in motivation to quit smoking). Similarly, providing CO feedback to light smokers was also examined to see if a brief health feedback intervention strategy is enough to increase motivation to quit light smoking. Second, this study assessed self-monitoring over an extended period of time (7 consecutive days) in a light smoking college population in order to achieve a better understanding of the most strongly associated factors to light smoking.

Hypotheses. With regard to participant change along the TTM continuum toward smoking cessation, degree of self-monitoring of personal smoking behavior (i.e., number of cigarettes recorded per day) as well as information of one's expired CO at baseline were posited to predict forward movement in motivation toward cessation. With regard to amount smoked per day, it was hypothesized that light smoking college students would smoke significantly more on the weekend days compared to weekdays. Second, smokers were hypothesized to smoke more in the evening and night compared to earlier parts of the day. Third, the presence of other smokers, the consumption of alcohol, and higher mood were all predicted to increase in cpd on a given day. Finally, an interaction was posited between the consumption of alcohol and the number of other smokers present in increasing cpd on a given day. Such an interaction was expected because alcohol and other smokers are both strong cues to smoke, and the combination of these two cues may further exacerbate amount smoked per day in light smokers.

METHOD

2.1 Participants

Institutional Review Board approval of this study was obtained prior to beginning recruitment for this study. Participants ($N = 118$) in this study were enrolled in courses where experimental or extra credit is available to students. Participants received experimental participation credit (4 credits) toward the final grades in their courses in exchange for their participation in this study.

Inclusion and Exclusion Criteria. Participants who reported smoking at least 1 cigarette a week and no more than 10 cpd were eligible to participate. These criteria enable maximal recruitment of the light-smokers at UTEP. Lastly, participants needed to assert that they had the ability to carry a pen or pencil to record at all times during the week of participation in order to increase the validity of times recorded.

2.2 Measures

Tobacco Consumption Diary (TCD). A 7 page diary was provided to all participants containing columns within which to record the time at which one smokes a cigarette, the location where the cigarette was smoked, the number of people present while smoking, the number of smokers present while smoking, and a Likert-scale mood rating. In addition, the TCD contained a binary item (yes/no) asking whether or not the individual was drinking alcohol at the time of the cigarette. Each page (1 day of recording) contained spaces for 10 cigarettes of information. If participants smoked more than 10 cigarettes on a given day, they were instructed to record the diary values for those cigarettes on the back of the page designated for that day. Many individuals did follow this procedure, thereby increasing the likelihood of valid estimates with

this TCD (see Adherence Section). The cover of the diary also contained a space for the date and time at which the participant was scheduled to return the diary. See Appendix A.

Demographic Information. Typical demographic data was collected for all participants such as ethnicity, age, participants' education attained, and the level of education attained by participants' parents, as well as their estimated amount smoked each day of the week. See Appendix B.

The Contemplation Ladder (CL). A measure of contemplation of quitting smoking developed by Biener and Abrams (1991) was administered to participants as a continuous Stages of Change measure in order to assess participants' movement toward quitting smoking. This measure was conceptualized as a continuous measure of motivation to quit smoking. It consists of 11 ladder 'rungs' and represents an 11 point Likert scale. The CL is thought to be less temporally bound than the original categorical staging algorithm developed by DiClemente et al. (1991) such that one need not be planning to quit within a certain time period (e.g., planning to quit smoking within the next 6 months are labeled as being in contemplation) in order to be considered in a given stage of change (Abrams, Herzog, Emmons, & Linnan, 2000). The CL has been found to be effective in detecting changes in smoking behavior (Herzog, Abrams, Emmons, & Linnan, 2000). See Appendix C.

The Fagerström Test of Nicotine Dependence (FTND). This scale measures the participants' degree of psychological dependence on nicotine (Heatherton, Kozlowski, Frecker, & Fagerström, 1991) and is the most commonly used measure for the purpose of assessing nicotine dependence (Steinberg, Williams, Steinberg, Krejci, & Ziedonis, 2005). The FTND contains 6 items that are summed to produce a score that can range from 0 to 10 with an increase in scores indicating a higher level of dependence to nicotine. These 6 items include a) the time to

the first cigarette smoked during the day, b) the ability to refrain from smoking in forbidden areas, c) the number of cigarettes smoked per day, d) if one smokes even when ill, e) if one smokes early in the morning, and f) which cigarette would be most difficult for the participant to give up. Heatherton et al. reported that the FTND has an internal consistency of .61 though the measure of sampling adequacy (MSA) was reasonable (MSA = .70) indicating a homogenous set of items assessing nicotine dependence. In college aged smokers, the FTND has been shown to have a coefficient alpha of .67 (Haddock, Lando, Klesges, Talcott, & Renaud, 1999); among relatively lighter smokers (average of 12 cpd), Etter, Duc, and Perneger (1999) reported a coefficient alpha as being greater than .70 for the FTND. Both The FTND and the CL will be completed at baseline and follow-up sessions. For this study, the baseline (α = .42) and follow-up (α = .45) reliabilities were low. These values, however, may reflect a floor effect of variability in this measure of nicotine dependence within many light smokers. See Appendix D.

Exhaled carbon monoxide (CO). CO, a by-product of smoking, was assessed with a Bedfont EC50 Micro III Smokerlyzer CO Monitor. To complete this measure, participants were asked to hold their breath for 15 seconds and then to strongly exhale in to a small tube connected to the CO monitor. This apparatus measures CO in parts per million (ppm) and is able to measure expired CO with an estimated precision of 99.8% (Hald, Overgaard, & Grau, 2003). That said, it is a gross measure of recent smoking behavior, and the stability of CO readings in light smokers is yet unknown. The benefit of expired CO measurement may be two fold even in light smokers. First, inclusion of CO can serve to increase accuracy of self-reported smoking (Benowitz et al., 2002). This effect is known as the bogus pipeline effect; although CO may be a relatively insensitive measure of light smoking, participants' perceptions of biometric health measures such as CO may improve reporting accuracy (Evans, Hansen, & Mittelmark, 1977; Murray & Perry,

1987). Second, examining CO measurements may provide light smokers with additional information that may alter motivation to quit smoking given the possibility that some light smokers do not always consider themselves smokers.

2.3 Procedures

This study entailed two sessions with each participant. The first session was an orientation session to the study, while the second session was devoted to returning the diary, follow-up questionnaires and CO testing, with the remaining time devoted to answering any participant questions about the study or cessation in general.

Research participation credit was prorated in two time periods, though participants received up to 4 credits counting toward the experimental credit portion of their Psychology course grade if they completed the study in a satisfactory nature. For attending and completing the orientation session, participants received 1 credit. For returning an acceptably completed TCD, they received an additional 3 credits. These 4 credits were prorated in this manner as the orientation session took approximately 1 hour to complete. By acceptably completing a TCD by recording all smoking activity over the course of 7 consecutive days, participants received 2 credits. Participants were also told that CO verification would be used to confirm their accurate reporting of their smoking behavior and that the acceptable completion of the diary was contingent upon their accurate reporting. *However, participants were only told this in order to increase adherence to recording their smoking behavior. Any participant who made a concerted effort to return a completed diary was given the full 2 credits for participation for completing the TCD, regardless of CO measurement or total number of cigarettes recorded* (providing that a diary did not have a substantial amount of missing values for cells in the diary when one reported smoking a cigarette). Participants returned the TCD at a follow-up time that was convenient for

both the participant and the investigators not less than 7 days later. Subsequent to returning the TCD at follow-up, participants were provided CO feedback, completed follow-up questionnaires including the CL, FTND, and relevant demographics. For this follow-up session, participants received their 4th experimental participation credit.

Orientation Session. Upon arriving to the orientation session, all participants were provided with an informed consent form. This session was comprised of all who signed up for that particular time to participate in the study. For example, if one person signed up, the session was an individual session; if more than 1 person signed up, it was a group session with a maximum of 10 participants at each session. Two graduate students and two undergraduate students conducted these sessions in order to maximize available times for participants to sign up to participate each week. Each session followed a protocol whereby participants were informed of the requisite participation requirements for full credit: a) they record all that they smoke in the next 7 consecutive days, b) complete a number of questionnaires, c) have their expired CO measured, and d) return for a follow-up session where they return the TCD and complete orientation session tasks (CO feedback and questionnaires) again. Participants were instructed to begin recording at the beginning of the next day when they wake up. If participants consented to participate under these stipulations, they were asked to review and sign the informed consent. If they chose not to participate, they were thanked for their time and dismissed. While not specifically recorded, the number of individuals who opted not to participate was extremely low. No credit was given to these individuals.

It should be noted that the TCD required participants to report their alcohol consumption, though many individuals in the Experimetrix pool were under the age of 21 at the time of participation. Participants were informed that while all personal information provided in the

study will remain confidential, in the very unlikely event that researchers are subpoenaed to provide records of an individual's alcohol consumption, researchers would be required to provide this information. These steps were taken to ensure the safety and well being of participants under the age of 21 who may report alcohol consumption within the TCD.

Those who consented to participate were provided a packet of questionnaires containing the demographic information questionnaire, the CL, and FTND. Participants were asked to complete these questionnaires at that time. Once participants completed all baseline measures, they were individually taken into a separate, private, room and asked to exhale in to the CO monitor. A random half of those who had their expired CO measurements were informed of their expired CO and this information. For those who expired a negligible amount of CO due to not having recently smoked, CO information was provided (i.e., CO is a poisonous gas that accompanies smoking). Debriefing (described later) further explained to light smokers the salient issues regarding CO and light smoking (e.g., length of time in the lungs and bloodstream).

The other random half of participants were assigned to remain uninformed of their expired CO reading at baseline. If participants inquired about their reading, the researcher informed these individuals that they cannot be given this information at the present time. Participants were also informed that subsequent to finishing the study (i.e., returning the acceptably completed TCD and completing the follow-up session), they would be informed of their expired CO at that time. This manipulation served as an estimate of whether brief biometric health information is associated with a move toward quitting smoking (defined as a change in motivation to quit smoking within the CL).

All participants were then provided a TCD. The researcher began with instructions and training of how to properly complete 7 consecutive days of recording in the TCD regardless of

whether they smoke no cigarettes on one or some of the 7 consecutive days. Participants first were instructed to begin completing the diary on the next day (i.e., in the morning of the day after the day in which individuals participated in the baseline session). Once informed of this stipulation, participants were asked to follow along through the 1st page of the TCD to understand what was being asked of them each time they would smoke a cigarette (i.e., the time at which they smoked the cigarette, the location, the number of people present who the smoker is acquainted with, and the number of smokers the participant is around at the time of the cigarette) as well as their mood rating during the cigarette. Special effort was paid to asking participants to only record, within the *total people* section of the TCD, those with whom the smoker was acquainted. For example, if one were smoking in a bar, the number of people in the bar was not to be recorded as the total number of people. Rather, only the number of people the person was in attendance with while at the bar. At this time, participants were also instructed that despite the requisite that they cannot smoke more than 10 cpd to be included in the study, were they to exceed 10 cpd, to simply continue to record those cigarettes and the associated measures on the back of the page. Participants were also instructed to record whether they were drinking alcohol at the time of smoking. Finally, participants were instructed to record all diary values in real-time. That is, participants were asked to record each cigarette in the TCD at the time of the cigarette.

Upon description of the items contained in each page of the TCD, participants were provided with a worksheet (see Appendix E) that was exactly like a page in the TCD. Participants were provided a hypothetical situation in which an individual smokes a certain number of cigarettes. Participants were then instructed to fill in the day of smoking for the hypothetical participant. The intent of this exercise was to provide participants with a better

understanding of what is required of them when they leave the orientation session as well as the time it takes to fill out information for a single cigarette (approximately 10 to 20 sec.). Once the worksheet was completed, participants were given a chance to ask all questions they have. When it was clear all participants understood the TCD, they were asked to sign-up for a follow-up session not less than 7 days later. The time at which the person actually returned beyond the 7 days s/he filled out the diary (i.e., their time spent "out") was included as a covariate in motivation change analyses. Participants were then asked to provide researchers with a valid email address which they check regularly. Participants were also asked to give a viable phone number, should email not be working. Once the return date of the TCD was arranged, the date of their scheduled return was written down on the front cover of their TCD to provide a reminder to return the diary on the arranged date. Subsequent to setting an appointment to participate in the follow-up session, participants were then thanked for their time and participation, given an opportunity to ask any additional questions they had, and again were informed that they received 1 credit for their orientation session participation. Finally, participants were reminded to email or call the Prevention and Treatment in Clinical Health (PATCH) lab (email address and phone number were located on the 1st page of the TCD) were they to have any other questions or encounter any difficulties in recording their smoking behavior in the subsequent 7 consecutive days. Each orientation session lasted approximately 1 hour.

Participant No-Shows and lost TCDs. Participants who did not attend the session they originally scheduled were contacted by their preferred email a total of 4 times (once every 2 days subsequent to the no-show date). These emails reminded them that they still needed to return their TCD and we wanted to help them to do so. If no response was encountered by the 4th email, participants were then called once to reschedule. If no response was encountered by the

participant at this point, we ceased contact attempts with the participant. This scenario resulted in 6 cases of (approximately 5%) attrition. These individuals received a total of 1 credit in Experimetrix for their work at the orientation session. All other individuals who returned with an acceptably completed TCD received a total of 4 credits (1 for the orientation session, 2 for acceptably completing the TCD, and 1 for returning the TCD and completing the follow-up procedure (see *TCD Return Session* below)). Participants who lost or damaged (beyond legibility) their TCDs were welcomed to fill out another TCD. This scenario happened twice, and both individuals completed another TCD for full (4) credit.

TCD Return Session. In the TCD return session, participants returned the acceptably completed (7 consecutive days of recording) TCD to the researcher. Participants returned their records a median of 2 days after the end of recording in the TCD, with 95% participants returning for follow-up within 2 weeks of ending the recording period. The researcher briefly examined data in the TCD to make sure that it was consistent with their previous reports of how much they smoke on average. This time also served to provide the participant with answers to any questions s/he may have had in recording, Researchers also addressed any concerns participants may have had regarding either the study itself or smoking cessation at this time. Participants were then asked to complete demographic information (e.g., timeline follow-back), the FTND and CL measures to compare with baseline FTND and CL measurements. Subsequent to completion of these measures, participants were then asked to provide a second expired CO measurement assessment. Regardless of randomly assigned condition (CO feedback/No CO feedback), all were informed of their CO reading and its impact on the body at the TCD return session unless they expressed a desire to remain uninformed of the result at the return session. At this time, all participants were debriefed as to the intention of the study. Within this debriefing

session, regardless of amount of CO expired at both the baseline and follow-up sessions, participants were informed of the seriousness of CO inhalation that occurs as a result of any amount of smoking. Participants were then asked if they had other questions or concerns. If they did not, they were thanked for their time, informed that they would receive their full 4 credits shortly (<1 day), and excused. The TCD return session lasted approximately 20 to 30 min.

2.4 Motivation Change Approach to Analyses

Motivation changes subsequent to participation in the study were analyzed with a series of 4 nested hierarchical linear regressions (HLRs) and a full model (all predictors of interest) predicting follow-up CL score. Each HLR was conducted in two blocks. The first block included control variables potentially related to motivation at follow-up though not directly of interest in the study. These predictors included participants' age, gender, baseline motivation level (i.e., their baseline CL score) and baseline FTND scores, as well time to follow-up.

The first nested model included only the self-monitoring variable of cigarettes recorded. The second model included both cigarettes recorded and CO feedback as block 2 predictors of motivation change. The third model included only CO feedback and baseline expired CO level; CO level is an appropriate block 2 control variable for CO feedback given that all individuals in the study were light smokers. The fourth model included CO feedback, baseline expired CO, and the interaction of the two variables. The last model included all four block 2 variables.

Model Assumption Analysis and Testing. A square-root transformation was performed on age, time to follow-up, and baseline expired CO readings to adjust these variables to conform to a reasonably normal distribution. Higher powered terms were not necessary to improve model fit (all *p*s > .28). However, heteroscedastic variance tests for each of the models were at or near the nominal $p = .05$ value of significance (see Table 2, Appendix G). Because the use of unequal

error distributions would violate regression assumptions and lead to inaccurate models, all five models discussed in the results section were estimated with a robust sandwich estimator to ensure the most accurate model estimates.

The resulting iteratively reweighted least squares models estimated with robust standard errors were compared with corrected Akaike Information Criteria (AIC_c) appropriate for small samples (cf., Burnham & Anderson, 2004; Hurvich & Tsai, 1995). This approach enables selection of the most parsimonious model which fits the data based on the log-likelihood estimate of the model specified. Subsequent to this procedure, zero centered AIC_c values were compared on a chi-square distribution to assess which model most closely fit the observed variances and covariance of the data.

2.5 Predictors of Light Smoking Approach to Analyses

Data Reduction. Time of day was recoded into four time periods. This was done as collapsing the data based on a continuous variable would produce nonsensical numbers for each day. These four time periods were: a) from 5:00am to 11:59am, b) from 12:00pm to 4:59pm, c) from 5:00pm to 9:59pm, and d) from 10:00pm to 4:59am. Despite the last category technically encompassing two days, many individuals may have smoked in the early morning hours prior to going to sleep, and these cigarettes are appropriately considered part of the tally of cigarettes for the prior day, rather than cigarettes of the following day. These time periods were chosen as the activities in these time periods may reasonably overlap. In a similar manner, reported location of each cigarette smoked in the TCD was coded into one of 8 categories. These categories included: a) a house or apartment, b) bar or club, c) restaurant, d) school, e) work, f) car, g) a party, or h) "other" location. In subsequent analyses, the "other" category was excluded as the variety of

locations it included would not result in a variable of predictive utility. It was not a statistically significant predictor in models run however.

All variables in the TCD were collapsed within each participant and, within each participant, each of the 7 days they recorded to enable prediction of the amount of cigarettes smoked each day when an individual does smoke. Values of TCD variables for days in which the individuals did not smoke were thereby unavailable for analyses (i.e., there were no random time points during non-smoking days for comparison to times when cigarettes were smoked). Cigarettes recorded were counted in each day for each participant. The number of cigarettes smoked in a given time period, location, and the number of times a cigarette was smoked when the individual was consuming alcohol (binary variables) were summed for each day. Lastly, the median number of people present (versus mean persons present), median smokers present, and participants' median mood ratings (due to potential violations in normal distributions of mood in a given day) recorded each day were collapsed into values for each of the seven days within each participant.

Distribution Analysis and Modeling Approach. A number of individual predictors were submitted to a negative cube-root transformation. Average number of persons present, smokers present, number of times alcohol was present, all four times of day, and specific locations (home/apartment, school, and car) Bar/club cigarettes, restaurant cigarettes, work cigarettes, and party cigarettes were limited enough within each day whereby the distributions were essentially binomial and were recoded as such.

The dependent variable of interest in analyses was cigarettes smoked per day on smoking days in light smokers. First, the distribution contained no probability of 0 counts within days, thereby making the distribution zero-truncated. Second, the distribution was also overdispersed

with the variance exceeding the mean of the distribution—an assumption necessary for poisson regression. To adjust for this distribution of the data, a zero-truncated negative binomial modeling approach was used. Furthermore, because each of the days in which TCD data were recorded were nested within the individual smoker, the variances and resulting standard error estimates for each model were adjusted as such. This approach was taken because observations within each person's TCD can be considered non-independent within that person. Any model estimating these "nested" observations must adjust for the non-independence of these observations in order to attain accurate estimates of effects in each specified model. The resulting estimates of each of the models are presented in terms of Incidence Rate Ratios (IRRs). IRRs represent a standard presentation of how a rate (or count) would change given the presence of a factor relative to when the factor is absent. The IRR is analogous to the odds ratio in logistic regression as an effect estimate, except that instead of the outcome being a distinct category (or categories), the outcome is a rate or count variable. When a factor is present (versus absent), then the resulting IRR indicates the change in the rate of the count outcome (e.g., amount smoked).

Model Nesting. Similar to motivation change approach to analyses described above, 5 nested models were examined in addition to a full model with all predictors of interest. In all models, gender and baseline FTND score were included in the model to adjust parameter estimates for main predictors of interest (i.e., those recorded in the TCD). The first nested model included only the more psycho-socially oriented variables of persons present, smokers present, alcohol present, and mood. The second model included only the day of the week using effect coding. The third model included the time variables representing the total number of cigarettes smoked in the given time period for that day. The fourth model included only the 7 unambiguous location variables representing the total number of cigarettes smoked in the given location for

that day. The fifth model included all variables included in the four previous nested models, but excluded the interaction of the amount of smokers present with the number of times alcohol was being consumed during cigarettes recorded. The final model included this interaction between smokers present and amount of alcohol consumed in a given day.

2.6 Power Analyses

Power of the Motivation Model. Power was based on an overall model R^2 deviation from 0, as some predictors were expected to be partially related to other predictors. The two effects of particular interest in this study were those of self-monitoring on motivation to change smoking behavior and the effect of CO feedback in motivating change of smoking behavior. These a priori calculations based on self-monitoring (Mullen et al., 1997) and CO feedback (Abueg, Colletti, and Kopel, 1985) resulted in a combined effect size of $R^2 = .14$ ($f^2 = .163$). A multiple regression power analysis was conducted with Power $(1 - \beta) = .80$ and a two-tailed $\alpha = .05$ considering this effect size. Using these values, a sample size (N) of 85 participants was required in order to detect an effect of relevant predictors in the model.

Power of the Zero-Truncated Negative Binomial Regression Model. The literature for power analysis for negative binomial models, much less zero-truncated negative binomial models with cluster adjustment is non-existent. Related to this, computing programs to estimate such models are still limited and so the lack of implementation may also contribute to the lack of information on power of over-dispersed clustered count models. Nevertheless, many assessment studies which have conducted clustered momentary assessments similar to the present design have had similar sample sizes of both persons (Moghaddam & Ferguson, 2007; Piasecki, Richardson, & Smith, 2007; Shiffman, Paty, Gwaltney, & Dang, 2004) and events (Moghaddam & Ferguson, 2007; Piasecki, McCarthy, Fiore, & Baker, 2008; Shiffman et al., 2004; Shiffman et

al., 2002). Hence, to the extent that many recent studies have been adequately powered, the present study is also adequately powered.

RESULTS

3.1 Tobacco Consumption Diary and Motivation Change Results

Description of the Sample. A total of 124 participants were seen at baseline, and 118 participants returned for follow-up. This constitutes a 5% attrition rate. Participant characteristics are illustrated in Table 1 (see Appendix F). Fifty-four percent of the sample was female, and the majority of the sample was comprised of either Hispanic/Latino (65%) or Mexican National (15%) participants. Participants had an average age of 19.57 years (SD = 2.52). Eighty-two percent of the sample reported smoking at least once per week, with 42% of the entire light smoking sample reporting daily smoking with an overall average of approximately 3 cpd (M = 2.93, SD = 2.52). Smokers identified themselves by a variety of terms—social (46%), light (25%), or regular (24%) being the most prevalent classifications, and participants continued to classify themselves the same way after the intervention, γ = .91 (.01). Similarly, the degree to which participants changed their perception of smoking on a likert scale did not change at follow up either, t (117) = .37, p > .71. At baseline, participants expired a median CO level of 2 ppm, and this value did not change for follow-up levels (Z = -.06, p = .95). Lastly, FTND scores were also not significantly different between baseline and follow-up, t (117) = -.55, p = .58 (baseline M = .92, SD = 1.02; follow-up M = .96, SD = 1.10).

Motivation Change Analyses. At the univariate level, CL contemplation ladder motivation did not significantly change, t (114) = .96, p = .34 (baseline M = 5.09, SD = 3.20; follow-up M = 4.85, SD = 3.28). At the multivariate level, the four nested hierarchical regressions and the full model differ in variable impact on motivation (see Table 2, Appendix G). Block 1 of all five models included control variables expected to be influential in follow-up motivation levels. These variables included baseline motivation, follow-up lag, baseline FTND,

age, and gender. The first nested model including only self-monitoring (cigarettes recorded) in the second block did not result in a significant increase in variance explained in follow-up motivation, $R^2 = .00$, F (1, 94) = .07, n.s., nor was cigarettes recorded a significant predictor of follow-up motivation, $\beta = -.02$, n.s. In the second nested model, the CO feedback indicator was also included in block 2 of the model. Feedback was a significant predictor, $\beta = -.15$, $p < .05$, in this model, though the variance the second block explained was not significant, $R^2 = .02$, F (2, 92) = 2.39, n.s., in the second nested model. In the third nested model, feedback and baseline expired CO were included in the second block of the model to understand the impact of only biometric feedback dynamics in motivation level at follow-up. Feedback was again a significant predictor, $\beta = -.15$, $p < .05$, in this model, though the variance the second block explained was still not significant, $R^2 = .02$, F (2, 93) = 2.49, n.s., in the third nested model. Baseline CO, within this third model, also does not appear to adjust the influence of feedback indicated by both no change from the beta weight between nested models 2 and 3 nor a significant effect for expired CO, $\beta = .03$, n.s., though this effect would not be expected outside of an interaction between feedback and level of expired CO on follow-up level of motivation. In the fourth nested model, this interaction term was included, $\beta = .00$, n.s., and this term did not attenuate the influence of feedback, $\beta = -.15$, $p < .05$, on follow-up CL motivation. However, the variance change between block 1 and block 2, $R^2 = .02$, F (3, 92) = 1.64, n.s., was again not significant. The full model added the self-monitoring variable to the second block of the model; this block again did not contribute to a significant amount of variation in follow-up motivation, $R^2 = .02$, F (4, 91) = 1.24, n.s., and no predictor in the second block of the model. Additionally, the significant effect for feedback, $\beta = .15$, n.s., also fell away.

Because of the lack of significant variance explained by any of the intended motivation change variables, nested models are of limited utility in best explaining observed motivation in light smokers. Again, traditional means of empirically testing nested multiple regressions cannot be conducted because the robust estimate of error variance for each model is not equivalent to the robust estimate of error variance of a separate model. One existing module for testing non-nested models does exist, but the implementation relies on standard ordinary least squares estimates at present—no longer viable with robust estimation. Accounting for model parsimony however, Model 3 ($AIC_c = 434.38$) is the most parsimonious, though compared on the theoretical chi-square distribution with 1*df* ($\chi^2 = 3.84$), model 3 is no different than models 1 ($AIC_c = 437.21$), 2 ($AIC_c = 434.57$), and 4 ($AIC_c = 436.79$) though all appear better, in terms of parsimony, than the full model ($AIC_c = 439.17$), under the theoretical chi-square distribution, $\chi^2 (1) = 4.79$, $p < .05$ (see Table 3, Appendix H). Model parsimony placed against the chi-square distribution suggests that consideration of any but the full models are appropriate which indicates that a model considering only the self-monitoring cigarettes recorded variable is as appropriate as a model considering only the feedback and expired CO variables, though again, none of models accounted for a significant amount of variance in motivation change.

TCD Recording Behavior. From the 118 participants, a total of 575 smoking days were recorded. Descriptive information attained from TCDs can be observed in Table 4 (see Appendix I). Participants recorded a median of 12 cigarettes ($M = 18.30$, $SD = 16.85$) within the 7 day recording period. Participants also returned for follow-up after the 7 day recording period an average of approximately 4 days later ($M = 4.27$, $SD = 4.02$), though the median value was 2 days. In the aggregate, participants did not record equally among the 7 days, $\chi^2 (6) = 12.43$, $p = .053$, with the highest number of recording days being Saturdays ($n = 95$) and the lowest being

Sunday (n = 58). Removing Sunday values from the distribution resulted in non-significant variability in the distribution, χ^2 (5) = 3.96, p > .56. The number of cigarettes recorded on each of the 7 sequential (1-7) days of the week was also not variable, χ^2 (102) = 107.77, p > .33. On the whole, this suggests that smoking was roughly equal among all 7 days of the week for those who participated in this study.

TCD Report Validity. The number of cigarettes recorded on each day of the week was compared to estimates of amount smoked each day of the week provided at baseline before introduction of the TCD. Daily smoking estimates correlated highly with actual cigarettes recorded in the TCD each day. Spearman correlations for Monday, r (71) = .73, Tuesday, r (74) = .70, Wednesday, r (79) = .57, Thursday, r (84) = .51, Friday, r (90) = .60, Saturday, r (92) = .48, and Sunday, r (55) = .59 suggest that there was reasonable similarity between actual recorded cigarettes and estimates of daily smoking provided prior to knowledge of the TCD tasks necessary to complete the study in an acceptable manner. All correlations had p values less than .0001. The correlation between the total estimated cigarettes smoked within the week and the actual cigarettes recorded in the TCD over the course of a week was also reasonably high, r (498) = .64, p < .0001. It should be noted that while the correlations were between .48 and .73, such moderately high correlations can be expected given the variability in smoking within light smokers on a daily basis.

3.2 Predicting Amount Smoked in Light Smokers

Within each of the six models (see Table 5, Appendix J), two variables not of interest directly in the study were controlled for in each of the six models estimated. These two variables were gender and baseline FTND scores—both to adjust for potential gender differences in smoking patterns as well as the level of psychological dependence one experiences throughout

the week of recording. The first model included these control variables as well as more psycho-social predictors of smoking included in the diary: the number of times alcohol was present during smoking, the median number of people present during smoking, and the number of smokers present during smoking, as well as the median mood ratings of each day during smoking. This model was significant, *Wald* χ^2 (6) = 108.59, $p < .001$. Interestingly, despite 46% of the sample identifying as social smokers, only the presence of alcohol proved to be a significant predictor of an increase in cpd, *IRR* = 2.37, $p < .001$, while neither increases in median persons present during the day or median smokers present during the day were predictive of increased smoking during the day (both *p*s > .45). Mood was also not influential in cigarettes smoked each day by light smokers ($p > .26$). Model 1 also contained a significant degree of over-dispersion of variance around the mean cpd, χ^2 (1) = 144.38, $p < .001$. Model fit for this first model can be compared with other nested models in Table 5 (see Appendix J).

The second model removed these psycho-social variables and included the effect-coded day variable. The second model included only day of the week as the effect coded predictor (Monday as the singular value effect code). This model was significant, *Wald* χ^2 (8) = 67.35, $p < .001$ (see Table 6, Appendix K for additional model fit statistics), with Tuesday, *IRR* = .82, $p < .01$, and Wednesday, *IRR* = .77, $p < .001$, having a lower rate of smoking on smoking days. Friday, *IRR* = 1.40, $p < .001$, and Saturday, *IRR* = 1.31, $p < .001$, had a higher incidence rate ratio of smoking relative to the grand mean of smoking in model 2—unadjusted for other relevant covariates. Thursdays and Sundays were both statistically non-significant in model 2. The model contained a significant degree of over-dispersion of variance around the mean cpd, χ^2 (1) = 253.32, $p < .001$, indicating consideration of only day of smoking as a risk factor does not account for the cigarette count of light smokers.

Model 3 included only the four time categories which represented the sum of cigarettes smoked in the respective time period during the day; this model was significant, *Wald* χ^2 (6) = 289.07, $p < .001$ (see Table 6, Appendix K for additional model fit statistics). All time periods were significant predictors of cpd: before 12pm, *IRR* = 1.60, $p < .001$, 12pm to 4:59pm, *IRR* = 1.59, $p < .001$, 5pm to 9:59pm, *IRR* = 2.28, $p < .001$, and 10pm to 4:59am, *IRR* = 2.58, $p < .001$. While all time periods were significant in this model, the model still evidenced a significant degree of over-dispersion of variance around the mean cpd, χ^2 (1) = 4.01, $p < .05$, thereby indicating that over-dispersion in the cpd smoked by light smokers is not entirely accounted for by the times at which the light smoker smokes more.

Model 4 included only variables representing the sum of cigarettes smoked in a given location. This model was significant as well, *Wald* χ^2 (9) = 200.14, $p < .001$ (see Table 6, Appendix K for additional model fit statistics). All locations were significant predictors including the house or apartment, *IRR* = 2.40, $p < .001$, at school, *IRR* = 1.63, $p < .001$, the car, *IRR* = 2.00, $p < .001$, a bar or club, *IRR* = 2.21, $p < .001$, a restaurant, *IRR* = 1.65, $p < .001$, at work, *IRR* = 1.26, $p < .05$, and at a party, *IRR* = 2.24, $p < .001$, though again, the model contained significant over-dispersion in cpd, χ^2 (1) = 41.39, $p < .001$.

Model 5 included all variables included in the previous 4 models and resulted in a significant model, *Wald* χ^2 (22) = 461.36, $p < .001$ (see Table 6, Appendix K for additional model fit statistics). When adjusting for other relevant TCD predictors in the previous models, the significant effect for the presence of alcohol was retained, *IRR* = 1.46, $p < .001$, though the other psycho-social predictors remained non-significant (all *p*s > .10). Adjusting for other covariates not accounted for in model 2, none of the days of the week were significant predictors of increased smoking (all *p*s > .09). However, all time periods in model 3 maintained their

statistical significance in model 5, as did the location variables in model 4 (see Table 5, Appendix J). Importantly, over-dispersion of the cpd was not present, χ^2 (1) = .17, $p > .34$, suggesting that model 5 adjusts for the over-dispersion observed in cpd counts.

The full model included all variables considered in model 5 as well as a specified hypothesis of the interaction between the median number of smokers present during a cigarette throughout the given day and the amount of alcohol present during cigarettes during that day. As with model 5, the full model was significant, *Wald* χ^2 (23) = 468.48, $p < .001$ (see Table 5, Appendix J, for additional model fit statistics). The interaction term was not significant ($p > .54$). Furthermore, the pattern of significant variables remained unchanged from those statistically significant variables observed in model 5 (see Table 5, Appendix J) and the model over-dispersion was also dissipated by the present model similar to model 5, χ^2 (1) = .19, $p > .33$.

Post-Estimation of the Best Fitting Model. Based on the AIC_c values (see Table 6, Appendix K) which enable selection of the most parsimonious models for the explanation of the data, model 5 appears to be the most parsimonious model (AIC_c = 1901.22). Post-estimation results were computed on this model.

First, because many variables were either dichotomous in nature or were transformed, the IRRs for each parameter estimate are not easily interpretable. That said, one can compare the strength of each of the 11 significant parameters in this model with each of the other significant parameters. Because this leads to 55 comparisons of parameters, the *p* value of these tests was Bonferroni corrected to a level of .0009 (.05/55). The comparisons are presented in Table 7 (see Appendix L). As can be seen from this table, the most powerful predictors appear to be time of day parameters. Specifically, 5pm to 9:59pm cigarettes, are more predictive than school cigarettes, χ^2 (1) = 13.29, $p = .0003$. Cigarettes smoked between 10pm and 4:59am, as a variable,

appear to be stronger influences to an overall daily smoking rate than cigarettes smoked at school, χ^2 (1) = 22.85, $p < .0001$, in the car, χ^2 (1) = 12.50, $p = .0004$, in a bar or club, χ^2 (1) = 16.31, $p = .0001$, and in a restaurant, χ^2 (1) = 11.25, $p = .0008$. All other parameter estimate comparisons were non-significant.

Finally, because the variables chosen to be included in the TCD have all been associated with increased smoking by smokers including lighter smokers, considering the model's predictive validity is of concern and of potential applied utility. The resulting prediction equation for model 5 resulted in a predicted conditional median incidence rate of 2.47 cpd for light smokers in the study and a mean conditional incidence rate of 3.69 (*SD* = 2.71) cpd. These rates are fairly close to the actual observed cigarette incidence rates reported by participants including a median of 2.00 cpd and a mean of 2.93 (*SD* = 2.58) cpd. Indeed, the correlation between the linear prediction estimate of Model 5 with actual cigarettes reported in the TCD was reasonably high, r (572) = .85, $p < .001$. As such, a crude approximation of the variance in light smoking accounted for by this model is around 73% of the total variance in cpd smoked by light smokers.

Potential Reactivity and Under-Reporting. In terms of recording, participants appear to not have changed their recording pattern throughout the week with no significant variation in recording among the 7 consecutive days, χ^2 (6) = 6.99, $p > .32$. However, because under-reporting may have occurred for some more than others in the zero truncated cpd counts, a zero-truncated negative binomial model adjusting for participant as a cluster was computed with the main predictor being the day of recording. Day of the week was also entered in this model to adjust for the fact that, per model 2 of Table 5 (see Appendix J), smoking may be more likely to occur on some days and not others. Both predictors were effect coded to produce estimates in reference to the grand mean for that predictor. The results produced a significant model, χ^2 (12) =

42.52, $p < .001$, though the explanatory power of this model was due entirely to the day of the week and not the day of recording (i.e., no significant parameter estimates for day of recording). This further supports an interpretation that reactivity did not occur for participants. Furthermore, because motivation change did not occur and to the extent that motivation predicts behavior change, it is again unlikely participants reacted to recording to any significant degree. Finally, with regard to under-reporting of cigarettes smoked, the lack of systematic differences between recording days in the 7 day recording period not already associated with predictors in the nested models predicting cpd in light smokers suggests that any under-reporting may have occurred in a very unsystematic nature within each participant. Use of an estimator adjusting for the independent clusters in the data (i.e., participants) may have thereby additionally controlled, to a degree, the influence of any under-reporting on the models predicting cigarettes smoked per day by light smokers.

DISCUSSION

4.1 Motivation Change Discussion

Results of this study suggest that motivation toward quitting smoking was not increased through recording cigarette intake in a self-monitoring framework. This runs contrary to the theory that self-awareness of smoking behavior is potentially lacking in light smokers (e.g., McFall & Hammen, 1971; Rowan et al., 2007; Wicklund, 1975), but is consistent with findings in heavier smokers (Liebling et al., 1974). It is possible that 7 days of recording is not extensive enough to produce awareness of smoking behavior enough to motivate change. Relative to heavier smokers, light smokers have a lower base-rate of smoking and may not have recorded enough to elicit fuller awareness of their smoking. Alternatively, the amount of recording was sufficient, but systematic review and feedback of TCDs were not provided in the manner that CO feedback was provided in the present study. That is, once light smoking records were returned, a review of smoking within the record may be necessary to encourage direct cognitive awareness of smoking in the follow-up session. Furthermore, light smokers may not be experiencing cognitive dissonance in a manner which facilitates motivation change. A number of psychological mechanisms, such as optimism bias (discussed below), may be responsible for this observed lack of motivation change.

Both adolescents and adults who have quit (Rose, Chassin, Presson, & Sherman, 1996) or report interest in quitting (Riedel, Robinson, Klesges, & McLain-Allen, 2002) cite health concerns as the predominant reason for quitting. This may not be the case for light smokers in general however. While the most impactful factor in motivation of interest in this study appears to be CO feedback, such feedback resulted in a significant, though negligible, *decrease* in motivation to quit. This suggests two possibilities. First, it may indicate that, given a sufficient

amount of explanatory variance in motivation at follow-up, CO feedback promotes a decrease in motivation. Second, while the impact of CO negatively affected motivation in this study, the impact overall for a given individual is nil; CO feedback thereby has no effect on motivation to quit. Assuming the former scenario, this suggests that attempts to educate light smokers as to the potential current health impact that smoking is having, regardless of amount of CO they expire, actually is somewhat detrimental to their motivation to quit. Recently, a similar effect was found in community college smokers (M = 15cpd) where lung age and respiratory symptom feedback by a registered nurse was perceived as less relevant, and many smokers reported decreased worrying about their smoking as a result of the feedback (Lipkus & Prokhorov, 2007). The latter scenario (i.e., no impact of CO feedback) is consistent with evidence that motivation to quit smoking is highly transient over the course of short periods of time (0, 7, 14, and 30 day measurements), as measured by both the categorical stage of change algorithm and the contemplation ladder (Hughes, Keely, Fagerström, & Callas, 2005). Hence, variability trending toward lowered motivation to quit in a one to two week period, as in the present study, may be responsible for the observed follow-up levels of motivation. Notwithstanding this possibility, alternative theoretical explanations may be applicable.

Within the theory of cognitive dissonance, some discomfort is a requisite and because of this discomfort, an individual experiencing cognitive dissonance is motivated to change either behavior or attitudes in relation to the behavior through beliefs and rationalization of behavior (Festinger, 1957; Steele, 1999). This potential dissonance process may have taken a number of specific forms for light smokers including: disengaging from the feedback, self-exempting, and maintaining an optimism bias.

Light smokers provided CO feedback may have disengaged from this feedback by denying that any negative effects of their light smoking could exist, regardless of the extent of the CO they expired. Simply acknowledging that there *may* be health effects from even low levels of smoking may be discomforting, and one maladaptive cognitive solution to the presentation of this type of information is to deny the existence of such a possibility (Dijkstra & Brosschot, 2003; Steele, 1999), a powerful means of adapting to discomforting personal behavior in adolescents and adults (e.g., Bandura, Barbaranelli, Caprara, & Pastorelli, 1996; Klein, 2003). For example, similar to the real CO feedback condition in the present study, individuals presented with a scenario in which they were under a high probability of contracting a disease were far more likely to question the accuracy of the purported test relative to those given information which indicated they were at low risk for developing the disease (Ditto, Scepansky, Munro, Apanovitch, & Lockhard, 1998). Light smokers may indeed be differentially less critical of messages that do not implicate them as being at risk, while being more critical of high health risk messages (Liberman & Chaiken, 1992). For light smokers, it may be that it is easier to deny the health effects exemplified by any feedback, and if not outright deny the risk, at least question the accuracy of health information instead of changing personal motivation to quit. This may represent a maladaptive approach to coping with the discomfort of feedback within the cognitive dissonance framework. Moreover, it suggests that health education in the form of health feedback may permit light smokers to implicitly or explicitly question the validity of messages that run counter to their preconceived notions of the risks they face as light smokers and, subsequently, disengage from intervention.

For college students in particular, this disengagement from risk does in fact appear to take place. Smokers at 15 community colleges in Texas reported acknowledging that smoking

has caused some ambiguous overall health impairment while at the same time admitting no specific symptom—however small—related to their smoking (Prokhorov et al., 2007). Similarly, very light (1-5cpd) smoking adolescents appear to deny short term risks of smoking at a comparable or higher rate than regular smokers (Slovic, 2000). Moreover, for regular smokers and relapsers who report less worry about their smoking and its long term health related effects, these disengagement beliefs (e.g., denial or defensive cognitive processing) have also been found to be higher relative to those who report concern about the effects of smoking on their health (Dijkstra & Brosschot, 2003). From this perspective, it is possible that the very act of smoking implicitly forces a smoker (e.g., a light smoker, an experimenter, or a relapser) to downgrade his/her perception of its risk or else downgrade the validity of health information conveying the risk.

Second, and in a related vein, where complete denial of risk does not occur for light smokers, many may feel exempt from health consequences that *other* smokers surely face if they continue to smoke. If perceived prevalence or perceived personal risk is low, individuals may be inclined to think the risk is absent, they are somehow exempt from this risk, or they need not acknowledge such risk (Weinstein, 1989). For example, common self-exemption beliefs such as "skeptical" beliefs (e.g., "Smoking cannot be all that bad for you because many people who smoke live long lives."), "bulletproof" beliefs (e.g., "You can overcome the harms of smoking by doing things like eating health food and exercising regularly."), "worth it" beliefs (e.g., "You have got to die of something, so why not enjoy yourself and smoke."), and "jungle" beliefs (e.g., "Smoking is no more risky than lots of other things that people do.") are still widely believed by a range of smokers (Oakes, Chapman, Borland, Balmford, & Trotter, 2004). At the same time, many smokers may simply acknowledge the risks of smoking but maintain smoking nonetheless

(Milam, Sussman, Ritt-Olson, & Dent, 2000), perhaps perceiving that immediate benefits outweigh the long term costs of smoking. Given the endorsement by a wide range of smokers of beliefs such as the above noted bulletproof and jungle beliefs, it may be fairly easy for some light smokers to consider that the impact of their light smoking relative to other unhealthful behaviors is negligible or at least lower in a hierarchy of health concerns. This point may be especially salient in a U.S./México border community where concerns at the top of any such mental hierarchy of concern may include very basic necessities such as water quality, access to affordable healthcare, and personal and familial safety.

Overall, younger (e.g., adolescent) smokers, in general, still appear to perceive little or no risk for health and addiction consequences garnered from each cigarette smoked, perceive it takes an extensive amount of time to develop any amount of risk for development of health consequences, and plan to quit prior to those perceived risks ever occur (Hahn & Renner, 1998; Romer & Jamieson, 2001a; Slovic, 2000). The fact that light smokers in the present study had relatively low levels of both dependence and expired CO, neither of which were influential in motivation to quit, suggests that light smokers may have ease in maintaining an overly optimistic view of personal consequences to smoking as well as an ability to quit. This optimism may then provide justification for disengaging from health feedback about their present smoking behavior. This phenomenon is generally known as an optimism bias (e.g., Milam et al., 2000; Segerstrom, McCarthy, Caskey, Gross, & Jarvik, 1993; Weinstein, 2001) and it appears to be common in college smokers (Budd & Preston, 2001; Wechsler, Kelly, Seibring, Kuo, & Rigotti, 2001; Weinstein, 2001). In a range of studies, those classified as smokers (both adolescents and adults) appear to acknowledge some risk to smoking though, again, appear to apply this risk more to other smokers versus themselves (Milam, Sussman, Ritt-Olson, & Dent, 2000; Segerstrom et al.,

1993; Weinstein, 1999). Similarly, Gerrard, Gibbons, Benthin, and Hessling (1996, p. 352) have indicated that adolescent smokers in particular may be inclined to think "If it [a particular health consequence] hasn't happened to me so far, it isn't likely to happen at all." Encouragingly, as perceptions of smoking risk increase in adult smokers and sensitivity to overall health behavior risk increases in younger smokers, increases in rates of plans to quit are also observed (Romer & Jamieson, 2001b; Rose et al., 1996).

In examining what motivates adolescent smokers to attempt to quit, increased levels of health concern are observed the more the adolescent smokes, potentially the result of physical effects of smoking making future health consequences of perceived greater likelihood (Riedel et al., 2002). However, this presents a major roadblock for interventions for light smokers—many of whom may not, at present, be experiencing any health effects from low levels of smoking. This issue is compounded by the fact that some (12%) of the light smokers in the present study did not expire any CO. This effectively limits the amount of immediate insight a health professional can provide to some light smokers. Furthermore, under the cognitive availability heuristic (Tversky & Kahneman, 1974), light smokers may not have any significant reference person from which to observe any potential detriment *as* a light smoker or from which to judge a significant decrement from light smoking in their everyday lives. Instead, light smokers may have an "average smoker" prototype to which they feel they can reasonably compare themselves. This average smoker prototype is less impactful than a specific comparison individual (Klein, 2003; Weinstein, 2001) and so light smokers may be left with no prototype for the effects of smoking other than the "pack a day" smoker—clearly not light smoking. This prototype might also be conceptualized as the worst case smoker (Weinstein & Klein, 1995), which would enable light smokers to more extensively distance themselves from perceptions of consequences

developing from their current lower levels of smoking. In this scenario, light smokers may also be able to distance themselves from conceptualization as a smoker if they perceive their smoking will never escalate, especially if they have it in their minds that they will quit reasonably soon.

4.2 Implications for Intervention

Based on optimism bias implications, one strategy may be to provide a light smoker with an actual light smoker who demonstrates progression to regular smoking and challenges associated with cessation. For example, a modified CBT technique known as norm-setting (Dodgen, 2005) might be employed by providing a more salient, accurate prototype (e.g., smokers who were at one time light smokers) which may enable a closer reference than the "average smoker" prototype (Klein, 2003) in assessing the treatment provider's message. In doing so, a concrete example of smoking escalation, challenges to cessation, and ultimately successes in quitting may be better received by light smokers, potentially prompting cognitive and behavioral change.

One other strategy with potential is encouragement of self-affirmation. This approach validates the healthful qualities of an individual's life prior to presentation of information which may be perceived as negative. Self-affirmation maintains a person's ability to maintain self-worth (Steele, 1999) and, importantly, seems to reduce the bias on personally relevant health information and may increase the ability to cope with the more emotional effects of negative content in personally relevant health information feedback (Reed & Aspinwall, 1998). Indeed in lower socio-economic strata, engaging in self-affirmation prior to being presented with health information about smoking results in an increased acceptance of the presented information (Armitage, Harris, Hepton, & Napper, 2008). Consistent with Armitage and colleagues'

suggestions, the present data may suggest that self-affirmation may be a useful gateway component to establishing rapport and subsequently intervening with light smokers.

Lastly, smoking can be conceptualized as a behavior that occurs one cigarette at a time (Slovic, 2000) and occurs at a more experiential level than a rationally planned level of processing (Epstein, 1994; Slovic, 2001). Put another way, smoking may be more for very immediate pleasure or for relief of discomfort instead of logically planned (weighting risks versus benefits of smoking). To the extent to which this possibility is correct, light smokers may disengage from the health information or feedback, thereby preventing motivation change toward quitting. To that end, interventions would do well to call attention to salient triggers to smoke (cf., Dodgen, 2005). The second portion of this study addresses potential triggers to light smoking which may be targeted for both cognitive (e.g., Haas, Muñoz, Humfleet, Reus, & Hall, 2004; Hall, Muñoz, & Reus, 1994; Shadel, Mermelstein, & Borrelli, 1996) and behavioral (e.g., Carlson, Taenzer, Koopmans, & Casebeer, 2003; Haas et al., 2004; Hall et al., 1994) change.

4.3 Predictors of Amount Smoked Per Day in Light Smokers

Broadly, the most influential variables encountered in the TCD provide evidence both to the contrary and in favor of a number of previous findings in momentary assessments of smoking behavior. First, and contrary to a number of studies' findings (e.g., Chandola et al, 2004; Murphy-Hoefer et al., 2004; Ridner, 2005) social aspects of smoking (i.e., persons present and smokers present), and the day of the week (i.e., the weekend) were not influential in total cigarettes smoked per day. Consistent with other studies (e.g., Krukowski et al, 2005; Shiffman & Paty, 2006) however, alcohol consumption, evening and night-time smoking, and a variety of locations were influential in cigarettes smoked per day. Overall, light smokers appear to be cue

dependent smokers (e.g., Lazev et al., 1999; Sayette et al., 2005), and attention to significant cues may provide future avenues for light smoking intervention.

Findings Inconsistent with Hypotheses. First, within weekly time frames, a number of studies (Colder et al., 2006; Murphy-Hoefer, et al., 2004) have suggested that weekends are an at risk time for smoking in general. This study suggests light smokers may smoke frequently on the weekends, but no more extensively relative to other days of the week. As such, the day of the week may be less influential to smoking than situations that may occur more frequently during the weekend for light smokers, such as momentary situational influences to light smoking (cf., Shiffman & Paty, 2006). Bringing about awareness of these more contextual associations (i.e., cognitively and behaviorally) to smoking in light smokers is one avenue for intervention. However, not all contextual influences to light smoking are of equal influence. Specifically, two psychosocial relationships to the amount smoked per day by light smokers were expected but not supported.

Expected psycho-social relationships to light smoking over the course of the day included those of higher mood levels and the amount of persons present while smoking. Mood was unrelated to smoking which is discrepant with previous ecological studies (e.g., Aronson et al., 2008; Shiffman et al., 2007) and large scale surveys of past 30 day smoking (Emmons, Wechsler, Dowdall, & Abraham, 1998). Light smoking college students do appear to rate more positive feelings as a trigger to smoke compared to heavier smokers and less lower affect as a trigger to smoke, especially in the evening (Krukowski, Solomon, & Naud, 2005; Piasecki et al., 2007). At the same time, some evidence in college student smokers suggests that unhappiness is predictive of past 30 day smoking, yet pleasurable hedonistic activities were also associated with past 30 day smoking (Emmons, Wechsler, Dowdall, & Abraham, 1998). This is evidence

corroborated by Shapiro and colleagues' (2002) work with regular smokers. Adding to the ambiguity of mood and affect in relation to smoking in general, ecological momentary assessments have indicated limited influence of affect related variables (Shiffman et al., 2002; Shiffman et al., 2004; Shiffman & Paty, 2006)—consistent with the present study. However, mood in this study was collapsed across the day and was assessed uni-dimensionally to conserve space within the paper TCD. Hence, the measure of mood may thereby be tapping more of an overall mood or affect state. Alternatively, mood may be highly contextual in creating an urge to smoke (Shiffman et al., 2004), and positive mood appears to cue smoking but does not change mood post-consumption in light smokers (Moghaddam & Ferguson, 2007). Regardless, the present data suggest that overall mood throughout the day may not be influential on increased light smoking on a given day for light smokers. Finally, mood relationships to smoking, especially in lighter smokers, may be most affected by urge or craving to smoke (Shiffman & Paty, 2006), and it is possible that some examinations of mood and negative affect are confounded with urge to smoke. Indeed, much recent empirical and theoretical work has been devoted to the examination of craving to smoke, including craving and urges to smoke in intermittent and transitioning smokers (DiFranza et al., 2000; Sayette, Martin, Wertz, Perrott, & Peters, 2005). Craving to smoke may thereby be a more salient factor than mood for lighter smokers. In sum, clinical and research assessments of light smokers and interventions may do well to consider more momentary states of mood and craving than mood over the course of longer periods of time.

The second expected relationship not observed pertained to the number of persons present while smoking. This is inconsistent with a variety of studies (e.g., Flay et al., 1998; Krukowski et al., 2005; Shiffman et al., 2004; Shiffman & Paty, 2006). However, rather than a

quantitative (i.e., number of smokers present) association, the presence of others may be more qualitative, with the relationship of those around the light smoker having more impact on the likelihood of smoking than the number, per se, of other smokers around. For example, Piasecki and colleagues (2007) found a potent effect for friends smoking, with the presence of friends resulting in 5 times the likelihood of smoking in college students. Hence, light smoking may be better defined and assessed not only by considering amount smoked (e.g., a criterion of < 10cpd), but also by considering contextual qualitative (e.g., environmental, cognitive, and social) cues to smoking at a given smoking criterion.

Findings Consistent with Hypotheses. Hypothesized time of day, location, and alcohol associations to increased light smoking per day were largely supported. These associations are consistent with previous real-time and survey assessments in light smokers (cf., Shiffman & Paty, 2006), and plainly suggest that, in contrast to heavier smokers, early morning craving or urge to smoke is not present in light smokers. Rather, cigarettes smoked after 5:00pm, and particularly after 10:00pm are most influential to total daily smoking. Among four distinct clusters of smoker patterns noted from ecological momentary assessments by Chandra, Shiffman, Scharf, Dany and Shadel (2007), light smokers in this study resemble the "daily dip-evening incline" smokers who smoke very little in the later morning and mid afternoon, (with the exception of early morning cigarettes) and escalate their smoking after 5pm. Here however, likely given low levels of nicotine dependence and limited early morning smoking, no "daily dip" is observed, such that smoking simply escalates throughout the day. From a treatment perspective, light smokers in particular may benefit from a deeper examination as to what triggers may be present for them at night versus the rest of the day, or conversely, which prohibitive factors (e.g., a non-smoking workplace) may not be present at latter times during the

day which facilitate their smoking. To the extent that prohibitive factors may be present during the day, aiding light smokers to understand situation and time triggers (cognitive) to light smoking and develop *personal* prohibitive situations (cognitive-behavioral) in which smoking will not take place may be one reasonable cessation strategy.

Similar to time of day associations with light smoking, consistencies between previous literature were also observed with regard to smoking locations including the home (Shiffman & Paty, 2006; Shiffman et al., 2002), and a bar or restaurant (Shiffman & Paty, 2006; Shiffman et al., 2004; Shiffman et al., 2002). In line with these studies, smoking was also not associated with the workplace. Notably however, participants were instructed to record cigarettes smoked outside of areas where smoking is not permitted. While smoking restrictions do appear to decrease the likelihood of smoking in heavier smokers (Shiffman et al., 2002), but not relapsers (Shiffman et al., 2007), the present data suggest that environmental smoking restrictions may not necessarily be a deterrent to light smoking. This is specifically evidenced by the significant association between restaurant situations and escalating cpd in the present study. Some evidence also suggests the car is not an at risk time for smoking (e.g., Shiffman et al., 2002). However, other studies (e.g., Shapiro, Jamner, Davydov, & James, 2002; Shiffman et al., 2004) suggest a link between the car and heavier smoking. Consistent with these latter conclusions with regard to heavier smokers, the car does appear to be an at risk time for light smoking. Nevertheless, of the locations found to be associated with increased light smoking, no one location was more influential than another in relation to cigarettes per day smoked. This suggests that locations that are more social in nature are not necessarily more influential to smoking than less socially oriented (i.e., non-party, bar or club/antro) situations. The equality of all associations between locations and light smoking as well as the lack of association found between light smoking and

smokers present may also indicate that the label of social smoker may be inappropriate for many light smokers. Instead, locations found to be related to light smoking suggest a largely ideographic set of location triggers for many light smokers. Hence, light smoking interventionists may benefit from refining the search for specific triggers to smoking within a specific location in order to facilitate a deeper cognitive search for even more ideographic cues to smoking for a given light smoker. This approach may be one means of facilitating effective tailoring (e.g., Schumann, Ulrich, Ulbricht, Rüge, Bischof, & Meyer, 2007; Velicer et al., 2006) of a trigger oriented intervention component for light smokers.

Finally, alcohol was as strongly associated with increased smoking per day as any other association with light smoking assessed in this study. This is not surprising as the overwhelming majority of studies find a link between alcohol and smoking in general (e.g., Rose et al., 2004; Shapiro et al., 2002), in lighter smokers (Flay, Hu, & Richardson, 1998; Krukowski et al., 2005; Sayette et al., 2005; Shiffman & Paty, 2006; Shiffman et al., 2002), and in college students (Emmons et al., 1998; Mackey, McKinney, & Tavakoli, 2008; Patterson, Lerman, Kaufmann, Neuner, & Audrain-McGovern, 2004; Piasecki et al., 2007). Moreover, ecological assessments of alcohol and smoking together suggest that alcohol has a strong urge promoting effect on cigarette craving in real time and also reinforces the effects of cigarettes (Piasecki et al., 2008). The effect of alcohol on smoking would suggest that intervention considerations that address alcohol as a trigger to smoke are justified and necessary for efficacious intervention. It should be noted, however, that while the presence of alcohol overall is associated with increased light smoking, the hypothesized interaction between the number of smokers present and the presence of alcohol was not observed. It has been suggested that some alcohol associations with smoking can actually be better accounted for by others' smoking (Shiffman et al., 2004). Notwithstanding

the possibility of highly contextual associations between alcohol and other individuals smoking around the light smoker, this study suggests that the interaction of smokers and alcohol present is not as influential to increased smoking in light smokers as the mere presence of alcohol. The significant relationships between increased light smoking and parties, bars or clubs/antros, and the presence of alcohol overall are further supportive of this interpretation, as is survey evidence suggesting that parties and similar activities where alcohol is likely to be present are highly influential in smoking in college students (Colder et al., 2006; Emmons et al., 1998). Again, this bolsters the need for a focus on alcohol as a component of interventions for light smoking and college student populations.

4.4 Limitations and Future Directions

First, 7 days of recording in the TCD may not have been a sufficient amount of self-monitoring to affect motivation when the target behavior is of low base rate activity, as is the case with light smoking. To that end, more extensive periods of self-monitoring may be necessary to promote motivational change in light smokers. Second, while there was a range of motivation to quit in the current sample, sample size did not permit analysis of whether motivation change differed in strength or valence with CO feedback and self-monitoring within subsections of the motivational continuum (i.e., individuals that were lesser versus more highly motivated to quit). It may be that within subsections of the motivational continuum the impact of self-monitoring and CO feedback may be more impactful than was observed in the aggregate of the motivational spectrum assessed in this study.

With regard to variables selected for assessment in the TCD, small size and an effort to limit participant burden prohibited the inclusion of some potential influences of light smoking (cf., Shiffman et al., 2007; Shiffman et al., 2002). While an effort was made to choose the most

salient influences to light smoking, the present study also suggests that light smoking is likely highly ideographic. To the extent that this is true, methods of assessment and intervention may do well to attempt to tailor the intervention to the smoker as much as possible—as is recommended within motivational stage of change approaches to intervention (Velicer et al., 2006), in addition to permitting adequate feedback from the light smoker to the interventionist throughout assessment and intervention procedure.

Lastly, the ecological validity of paper records and the times at which records were made is always of potential concern, although paper records, questionnaire reports, and electronic momentary assessments tend to be moderately to highly concordant (Garber, Nau, Erickson, Aikens, & Lawrence, 2004). In line with this observation, values recorded in the present study were consistent with self-reports via questionnaires and verbal reports. When feasible, use of diary methods can be corroborated by survey methods and biological information such as CO measurements, as was done in this study. In addition, corroboration of recorded material via a clinician, independent observer assessment, more sensitive health biomarkers (e.g., thiocyanate), or real-time documentation (i.e., time and date stamp) may also be used to corroborate information recorded in a paper diary.

4.5 Conclusions

Self-monitoring activities and CO feedback appear not to be potent approaches to changing motivation in light smokers. In the case of CO feedback as an intervention component, underlying cognitive mechanisms (e.g., cognitive dissonance, denial of risk, and disengagement from the message) may actually work against the intended effect of health feedback for this category of smokers, though such an effect appears to be negligible. Future research is necessary to determine some of the underlying cognitive processing of health information for light smokers

and whether this type of processing is limited to health information and feedback for light smokers. This may help to more promote improved interventions to help light smokers quit.

Nevertheless, the present study suggests that many non-dependence motives influence amount smoked in light smokers—in line with conclusions from similar methodologies (e.g., Piasecki et al., 2007). Environmental triggers such as the increased presence of alcohol or situations in which alcohol is likely to be present, as well as latter times of day appear to be most influential to light smokers. Results also suggest that consideration of only a limited set of variables by both researchers and clinicians may limit understanding of light smokers and the effectiveness of interventions targeting light smokers. That is, a broad array of both time and situation dependent influences on light smoking throughout the day must be considered in order to effectively intervene upon light smokers. If limited in time or other resources however, focusing on non-dependence related influences of smoking such as alcohol triggers may be most efficacious. Furthermore, given the discrepancies in the literature between psycho-social variables such as mood and other smokers present in relation to light smoking, the present results do not preclude additional attention to these specific psycho-social influences to light smoking. Comprehensive assessments and interventions of light smokers will likely be more accurate and effective if cognitive and behavioral aspects of the bio-psycho-social associations to light smoking are more fully considered.

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APPENDICES

Appendix A
Tobacco Consumption Diary (TCD) Pages 1 – 9

PATxCH
PREVENTION AND TREATMENT IN CLINICAL HEALTH

Phone: (915) 747-5784
Email: patchlab@utep.edu

Return: _____

UTEP MINERS

Tracking Record

ID Number: _____

Began: _____

Instructions:

1. Write Down the Time (**Hour and Minute**) you had the cigarette.
2. **Circle** whether it was AM or PM.
3. Write down the location (e.g., **Bar, Restaurant, Home, School, Work, Driving, etc.**).
4. Write down the **total** number of people present with you at the time of the cigarette.
5. Write down the number of **smokers** with you at the time of the cigarette.
6. Write down your Mood (**1 = very low** mood, sad**, 7 = very high** mood, happy).
7. Were you drinking alcohol at the time of the cigarette? (**circle** yes or no).

Important: Please remember to record ALL Information per cigarette or else you will not receive full credit. Thank you for participating!

Day 1 **Date:** _____

Cig.	Time	am / pm	Location	# People	# Smokers		Mood (circle)		Alcohol?
1		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
2		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
3		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
4		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
5		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
6		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
7		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
8		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
9		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
10		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no

	Day 2									Date: _____
	Cig.	**Time**	**am / pm**	**Location**	**# People**	**# Smokers**		**Mood (circle)**		**Alcohol?**
	1		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	2		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	3		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	4		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	5		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	6		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	7		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	8		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	9		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	10		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no

	Day 3									Date: _____
	Cig.	**Time**	**am / pm**	**Location**	**# People**	**# Smokers**		**Mood (circle)**		**Alcohol?**
	1		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	2		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	3		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	4		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	5		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	6		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	7		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	8		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	9		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	10		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no

	Day 4									Date: _____
	Cig.	**Time**	**am / pm**	**Location**	**# People**	**# Smokers**		**Mood (circle)**		**Alcohol?**
	1		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	2		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	3		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	4		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	5		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	6		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	7		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	8		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	9		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	10		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no

Day 5							Date: _____		
Cig.	**Time**	**am / pm**	**Location**	**# People**	**# Smokers**		**Mood (circle)**		**Alcohol?**
1		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
2		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
3		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
4		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
5		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
6		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
7		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
8		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
9		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
10		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no

Day 6							Date: _____		
Cig.	**Time**	**am / pm**	**Location**	**# People**	**# Smokers**		**Mood (circle)**		**Alcohol?**
1		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
2		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
3		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
4		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
5		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
6		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
7		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
8		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
9		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
10		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no

Day 7							Date: _____		
Cig.	**Time**	**am / pm**	**Location**	**# People**	**# Smokers**		**Mood (circle)**		**Alcohol?**
1		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
2		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
3		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
4		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
5		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
6		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
7		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
8		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
9		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
10		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no

Appendix B

Demographic Survey

Participant # _____

CO: _____ (**For researcher use only; do not fill in)

Your *most frequently used* Email address: _____

Your *most frequently used* phone number: _____

Today's Date: _____

How old are you? _____

Gender: _____ Male _____ Female

With which ethnic/racial group do you identify with? (please check one)
___ Hispanic/Latino
___ Mexican National
___ White/Caucasian
___ Oriental/ Asian American/ Pacific Islander
___ Black/African American
___ Native American

Do you have family in Cd. Juarez? _____ Yes _____ No

Do you visit family in Cd. Juarez? _____ Yes _____ No

Do they come to visit you in the U.S? _____ Yes _____ No

What is your level of education?
_____ Less than High School
_____ High School or equivalent
_____ Some College
_____ Vocational School/Associate's Degree
_____ College Graduate (e.g., B.A., B.S.)
_____ Some Post-Graduate training

I am _____ Single (never married)
_____ Married
_____ Divorced
_____ Widow/Widower
_____ Separated
_____ Living with someone

How long have you lived in the U.S. (if ever)? _____ years

How long have you lived in México (if ever)? _____ years

May we contact you in the future to participate in an additional research study if paid? ____ Yes _____ No

Have you ever received Mental Health Services? _____ Yes
_____ No

If yes, what conditions were you treated for?
_____ Substance Abuse
_____ Depression
_____ Anxiety
_____ Post Traumatic Stress Disorder
_____ Other (please describe) _____

What is your smoking status?

_____ I smoke at least one cigarette per day; **If so, how many cigarettes per day?** _____
_____ I smoke 1 to 6 cigarettes per week
_____ I smoke less than 1 cigarette per week
_____ I smoke less than one cigarette per month
_____ I no longer smoke, but in the past smoked at least 1 cigarette per day;
If so, how many cigarettes per day? _____
_____ I no longer smoke, but in the past smoked 1-6 cigarettes per week
_____ I have smoked a cigarette or a few, just to try it
_____ I have never smoked before, not even a puff

To what degree to you consider yourself a smoker? (circle one number)

Not at all Completely

1 2 3 4 5 6 7

What kind of a smoker do you describe yourself to be?

_____ Heavy smoker
_____ Regular smoker
_____ Light smoker
_____ Social smoker
_____ Not a smoker.

Do you use cigars? _____Yes If so, how many per week? _____
_____ No

Do you use dip? _____ Yes If so, how much per week? _____
_____ No

Do you use chew? _____Yes If so, how much per week? _____
_____ No

On how many days did you smoke cigarettes in the last 30 days?
_____Number of days (please state your best estimate)

On the days that you smoked, what is the average number of cigarettes you smoked per **day**?
_____ Number of cigarettes per day (please state your best estimate)

At what age did you first try tobacco? _____

If you use tobacco, for how many years have you used at least once per day? _____

How many times have you quit using tobacco for at least one day? _____ None
_____ Once
_____ Twice
_____ Three times
_____ More than three times

When is the last time you tried to quit using tobacco? _____

What is the longest that you have ever quit tobacco? _____ I have never quit
_____ One day
_____ More than a day but less than a week
_____ One week
_____ More than a week but less than a month
_____ 1 to 3 months
_____ 4 to 6 months
_____ 6 to 12 months
_____ More than one year

During your longest quit attempt, did you gain weight? _____ Yes _____ No

If yes, how much weight did you gain? _____ Pounds (_____Kilograms)

In attempts to quit tobacco, have you ever used:

Nicotine patch __yes __no
Nicotine gum __yes __no
Nicotine inhaler __yes __no
Nicotine nasal spray __yes __no
Cold turkey __yes __no
Slowly cutting back __yes __no
Zyban (Bupropion, Wellbutrin) __yes __no
Nicotine lozenges ___ yes ____no

How interested are you in stopping your use of tobacco? _____ Not at all
_____ A little

_____ Some

_____ A lot

_____ Very much so

If you decide to quit tobacco, why would you consider quitting? (**choose only one**)

_____ Personal choice

_____ Health

_____ Person close to me wants me to (wife, child, friend, etc.)

_____ Tobacco is expensive

_____ My faith

_____ Other _____

Are you in general concerned about your weight? _____ Yes _____ No

Would you start smoking again if you gained:

20 pounds or more (9 kilograms or more) _____ Yes _____ No

18 – 20 pounds (8-9 kilograms) _____ Yes _____ No

16 – 18 pounds (7-8 kilograms) _____ Yes _____ No

14 – 16 pounds (6-7 kilograms) _____ Yes _____ No

12 – 14 pounds (5-6 kilograms) _____ Yes _____ No

10 – 12 pounds (4.5-5 kilograms) _____ Yes _____ No

8 – 10 pounds (4-4.5 kilograms) _____ Yes _____ No

6 – 8 pounds (3-4 kilograms) _____ Yes _____ No

4 – 6 pounds (2-3 kilograms) _____ Yes _____ No

2 – 4 pounds (1-2 kilograms) _____ Yes _____ No

0 – 2 pounds (0-1 kilogram) _____ Yes _____ No

How many pounds (or kilograms) gained do you think would prompt you to smoke again?

_____ Pounds (____ Kilograms)

IN THE CALENDAR BELOW, PLEASE FILL-IN YOUR SMOKING RATE AND TIME SMOKING DURING A **TYPICAL WEEK** IN THE **LAST 90 DAYS.**

First, think of *typical week* in the *last 90 days.* Try to remember as accurately as you can, how much and for how long did you typically smoke in a week during that 3 month period.

For each day of the week in the calendar below, fill in the number of cigarettes you typically smoked on that day in the upper box and the typical number of hours you smoked that day in the lower box.

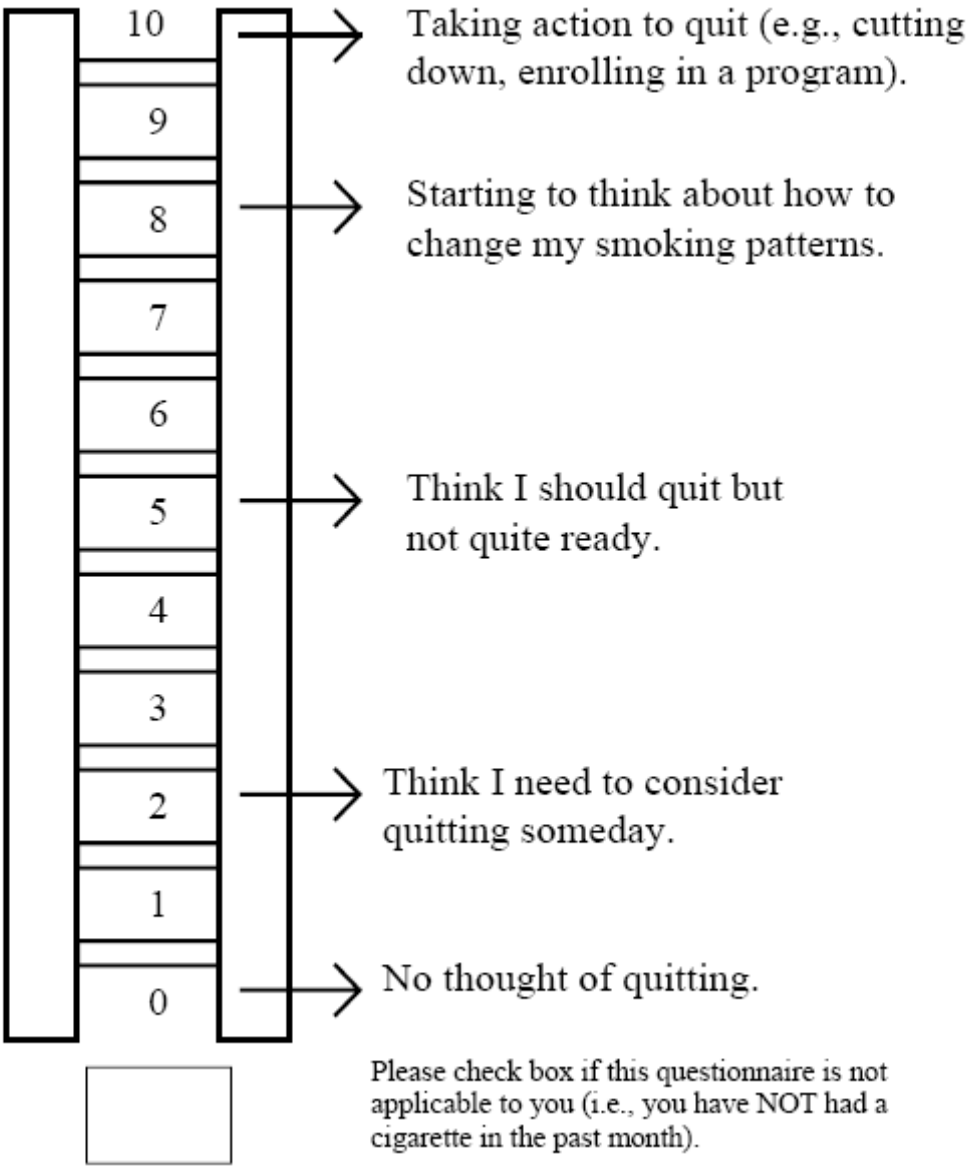
Day of Week	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Number of Cigarettes Smoked							
Number of Hours							

Appendix C

Contemplation Ladder

Contemplation Ladder

Please answer the following questions if you have smoked in the past month. Each rung on this ladder represents where various smokers are in their thinking about quitting. If you have smoked in the last month, please **circle** the number that indicates where you are now.



Appendix D

Fagerström Test for Nicotine Dependence (FTND)

FTND

1. How soon after you wake up do you smoke your first cigarette?
   - ____ 5 minutes or less
   - ____ 6 to 30 minutes
   - ____ More than 30 minutes

2. Is it hard for you to not smoke in places where it is not allowed like in church, at the library, or at the movies?
   - ____ Yes
   - ____ No

3. Which cigarette would you hate to give up the most?
   - ____ The first one
   - ____ Other: _____

4. How many cigarettes per day do you smoke?
   - ____ 10 or less
   - ____ 11 to 20
   - ____ 21 to 30
   - ____ 31 or more

5. Do you smoke more when you first wake up than during the rest of the day?
   - ____ Yes
   - ____ No

6. Do you smoke even when you are so sick that you are in bed most of the day?
   - ____ Yes
   - ____ No

Appendix E

Tobacco Consumption Diary Training Worksheet

	Day X							Date: _____		
	Cig.	**Time**	**am / pm**	**Location**	**# People**	**# Smokers**		**Mood (circle)**		**Alcohol?**
	1		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	2		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	3		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	4		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	5		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	6		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	7		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	8		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	9		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no
	10		am / pm				Sad	1 2 3 4 5 6 7	Happy	yes / no

Appendix F

Table 1: Participant Characteristics ($N = 118$)

Categorical Variables	*N*	%	
Gender			
Male	54	46	
Female	64	54	
Ethnicity			
Hispanic	77	65	
Mexican National	17	15	
Non-Hispanic White	20	17	
Other	4	3	
Self-Reported Smoking Status			
Daily	49	42	
1 to 6 cpd per week	47	40	
< 1 Cigarette a Month	13	11	
Experimenter	9	7	
Self-Described Smoking Behavior			
(Note: All smoked <10cpd some days)			
Non-Smoker	5	4	
Social Smoker	54	46	
Light Smoker	29	25	
Regular Smoker	28	24	
Heavy Smoker	2	1	
Continuous Variables	*Mean*	*SD*	*Median*
Age	19.57	2.52	19
Degree Consider's Oneself a Smoker	3.47	1.62	3
Average CPD Survey Response	2.93	2.58	2
Days Until Return of 7 Day TCD	4.27	4.02	2
Total Cigarettes Recorded in 7 Days	18.30	16.85	12
Contemplation Ladder Motivation Level		$t(114) = .96, p = .34$	
Baseline	5.09	3.20	5
Follow-Up	4.85	3.28	4
Expired CO		*Rank Sign Z* = -.06, $p = .95$	
Baseline	3.50	4.07	2
Follow-Up	3.56	4.17	2
FTND		$t(117) = -.55, p = .58$	
Baseline	0.92	1.02	1
Follow-Up	0.96	1.10	1

Appendix G

Table 2: Robust Hierarchical Regressions Predicting Motivation Change at Follow-Up

	Model 1			Model 2			Model 3			Model 4			Full Model		
Predictor	B	S.E.[b]	β	B	S.E.[b]	β	B	S.E.[b]	β	B	S.E.[b]	β	B	S.E.[b]	B
Block 1															
Baseline Motivation	.77	.08	.74***	.77	.08	.74***	.77	.07	.74***	..77	.07	.74***	.77	.08	.75***
Follow-Up Lag Time[a]	.03	.20	.01	.15	.23	.04	.15	.23	.04	.15	.23	.04	.12	.24	.03
Baseline FTND score	.20	.19	.07	.17	.20	.06	.14	.20	.05	.14	.21	.05	.15	.21	.05
Age[a]	.83	.86	.06	.60	.82	.05	.59	.80	.04	.59	.80	.04	.62	.84	.05
Gender (Female)	-.32	.41	-.05	-.48	.43	-.08	-.43	.44	-.07	-.43	.46	-.07	-.43	.46	-.07
Block 2															
Cigarettes Recorded	-.00	.01	-.02	.00	.01	.00							.00	.01	-.03
Feedback				-.90	.45	-.15*	-.91	.44	-.15*	-.91	.44	-.15*	-.89	.46	-.15
Baseline Expired CO[a]							.09	0.22	.03	.01	.27	.03	.14	.29	.05
Feedback X Baseline CO										-.01	.36	.00	.00	.37	.00
Block 1 Fit	F (5, 95) = 34.68***			F (5, 95) = 34.68***			F (5, 95) = 34.68***			F (5, 95) = 34.68***			F (5, 95) = 34.68***		
Block 1 R^2	.58			.58			.58			.58			.58		
Block 2 Fit	F (6, 94) = 29.82***			F (7, 93) = 46.94***			F (5, 95) = 34.68***			F (8, 92) = 42.19***			F (9, 91) = 37.35***		
Block 2 R^2	.58			.60			.60			.60			.60		
R^2 Change from Block 1 to 2	.00, F (1, 94) = .07, n.s.			.02, F (2, 92) = 2.39, n.s.			.02, F (2, 93) = 2.49, n.s.			.02, F (3, 92) = 1.64, n.s.			.02, F (4, 91) = 1.24, n.s.		
Model Diagnostics (non-robust):															
Test for Higher Powers	F (3, 91) = .28, n.s.			F (3, 90) = .56, n.s.			F (3, 90) = .46, n.s.			F (3, 89) = .46, n.s.			F (3, 88) = .45, n.s.		
Test for Heteroscedasticity	χ^2 (1) = 5.40*			χ^2 (1) = 3.36, p=.06			χ^2 (1) = 3.53, p=.06			χ^2 (1) = 3.54*			χ^2 (1) = 3.16, p=.07		

[a] Variables were square-root transformed prior to analyses due to positive skew and kurtosis.

[b] S.E.=Standard Errors: Huber-White Robust errors were estimated due to potential heteroscedastic variance in Follow-Up Motivation.

*p < .05, **p<.01, ***p<.001, n.s. = not significant

Appendix H

Table 3: Model Fit of Robust Hierarchical Linear Regressions Prediction Motivation

Model	*n*	ll(null)	ll(model)[a]	df	AIC	AIC_c	Δ^b	χ^2 *p*
Model 1	101	-254.26	-211.00	7	436.01	437.21	2.83	0.09
Model 2	101	-254.26	-208.50	8	433.01	434.57	0.19	0.66
Model 3	101	-254.26	-208.41	8	432.81	434.38	0.00	reference
Model 4	101	-254.26	-208.41	9	434.81	436.79	2.41	0.12
Full Model	101	-254.26	-208.36	10	436.72	439.17	4.79	0.03

Note: ll = Log-Likelihood, AIC = Akaike Information Criterion, AICc = small *n* correction.

[a] ll does not have same interpretation with robust estimator among nested models.

[b] Δ from most parsimonious $AIC_c = 0.00$

Appendix I

Table 4: TCD Recording Behavior (N = 575 Days)

Categorical Variables	*N*	%
Day of the Week		
Monday	75	13
Tuesday	78	13
Wednesday	85	15
Thursday	91	16
Friday	93	16
Saturday	95	17
Sunday	58	10
Count Variables [a]	*Median*	*Range*
Time Period		
5am to 11:59pm	0	0 - 10
12:00pm to 4:59pm	0	0 - 7
5pm to 9:59pm	1	0 - 6
10pm to 4:59am	0	0 - 13
Location		
House or Apartment	0	0 - 16
School	0	0 - 8
Car	0	0 - 9
Bar or Club	0	0 - 10
Restaurant	0	0 - 4
Work	0	0 - 3
Party	0	0 - 8
Other	0	0 - 17
Drinking Alcohol	0	0 - 17
No. of People Present[b]	2	0 - 25
No. of Smokers Present[b]	1	0 - 10
Mood[b]	5	1 - 7

[a] Count of Cigarettes Recorded Within Location, Time, or Situation

[b] Median Value for Cigarettes Recorded in a Given Day

Appendix J

Table 5: Zero-Truncated Negative Binomial Regression Models predicting CPD

	Model 1			Model 2			Model 3			Model 4			Model 5			Full Model		
Predictor	IRR	S.E.[d]	*p*	IRR	S.E.[d]	*p*	IRR	S.E.[d]	*p*	IRR	S.E.[d]	*p*	IRR	S.E.[d]	*p*	IRR	S.E.[d]	*p*
Demographics[a]																		
Gender (Female)	.75	.10	.04	.67	.11	.01	.87	.07	.07	.74	.08	.01	.89	.06	.10	.89	.06	.11
Baseline FTND	1.24	.06	.01	1.22	.07	.01	1.01	.04	.83	1.10	.05	.05	1.04	.03	.23	1.04	.03	.24
Potential Triggers																		
Alcohol Present[e]	2.37	.29	.01										1.45	.11	.01	1.43	.12	.01
Persons Present[e]	.83	.20	.45										.85	.09	.14	.87	.11	.29
Smokers Present[e]	1.07	.24	.76										1.15	.10	.10	1.15	.10	.10
Median Mood	1.04	.04	.26										1.01	.03	.66	1.02	.03	.59
Day of the Week[b]																		
Tuesday				.82	.06	.01							1.06	.06	.28	1.06	.06	.27
Wednesday				.77	.06	.01							.92	.05	.09	.92	.05	.08
Thursday				1.10	.08	.18							1.03	.06	.66	1.03	.06	.64
Friday				1.40	.10	.01							1.01	.05	.88	1.01	.05	.87
Saturday				1.31	.10	.01							1.01	.07	.88	1.01	.07	.90
Sunday				.87	.08	.15							1.06	.07	.38	1.06	.07	.37
Time of Day[c]																		
6am to 12pm[e]							1.60	.12	.01				1.58	.11	.01	1.58	.11	.01
12:01pm to 5pm[e]							1.60	.13	.01				1.52	.12	.01	1.52	.12	.01
5:01pm to 10pm[e]							2.28	.23	.01				1.83	.19	.01	1.82	.19	.01
10:01pm to 4:59am[e]							2.58	.23	.01				1.83	.14	.01	1.81	.14	.01
Location[c]																		
House or Apartment[e]										2.40	.22	.01	1.30	.10	.01	1.30	.09	.01
School[e]										1.63	.14	.01	1.15	.08	.04	1.15	.08	.04
Car[e]										2.00	.23	.01	1.20	.09	.02	1.19	.09	.02
Bar or Club										2.21	.20	.01	1.19	.08	.02	1.19	.08	.02
Restaurant										1.65	.14	.01	1.23	.09	.01	1.23	.09	.01
Work										1.26	.12	.05	.94	.07	.40	.94	.08	.45
Party										2.24	.21	.01	1.27	.13	.02	1.26	.13	.02
Interaction																		
Smokers X Alcohol																1.15	.28	.57
Likelihood Ratio Test of δ	χ^2 (1) = 144.38***			χ^2 (1) = 253.32***			χ^2 (1) = 4.01*			χ^2 (1) = 41.39***			χ^2 (1) = .17, *n.s.*			χ^2 (1) = .19, *n.s.*		
Model Dispersion	δ = .35 (S.E. = .10)			δ = .58 (S.E. = .16)			δ = .03 (S.E. = .02)			δ = .12 (S.E. = .05)			δ = .01 (S.E. = .01)			δ = .01 (S.E. = .01)		

[a] Age was restricted in range and estimation was problematic; it was not significant in converging models and so was excluded from models.

[b] Effect Coding was used and estimates are for the deviation from the grand mean for all days combined.

[c] Time of Day and Location categories are the sum of cigarettes smoked in that time period or in the respective location each day.

[d] S.E. =Standard Errors: Robust errors were estimated accounting for observations nested within persons.

[e] Variables are Inverse Cubic Log transformed to account for skew and kurtosis; **p*<.05, ***p*<.01, ****p*<.001, *n.s.* = not significant

Appendix K

Table 6: Model Fit of Zero-Truncated Negative Binomial Regressions Predicting CPD

Model	*n*	ll(null)	ll(model)[a]	df	AIC	AIC_c	Δ^b	χ^2 *p*
Model 1	572	-1232.81	-1150.68	8	2317.37	2317.62	416.40	<.001
Model 2	575	-1238.61	-1201.27	10	2422.53	2422.92	521.70	<.001
Model 3	575	-1238.61	-980.81	8	1977.62	1977.88	76.66	<.001
Model 4	575	-1238.61	-1057.32	11	2136.63	2137.10	235.88	<.001
Model 5	572	-1232.81	-924.42	25	1898.84	1901.22	0.00	reference
Full Model	572	-1232.81	-924.18	26	1900.36	1902.93	1.71	0.19

Note: ll = Log-Likelihood, AIC = Akaike Information Criterion, AICc = small *n* correction.

[a] ll does not have same interpretation with cluster estimator among nested models.

[b] Δ from most parsimonious $AIC_c = 0.00$

Appendix L

Table 7: Post Estimation Comparisons of Significant Estimates for Model 5

Variable	1	2	3	4	5	6	7	8	9	10	11
Alcohol Present (1)	--										
6am to 12pm (2)	1 = 2	--									
12:01pm to 5pm (3)	1 = 3	2 = 3	--								
5:01pm to 10pm (4)	1 = 4	2 = 4	3 = 4	--							
10:01pm to 4:59am (5)	1 = 5	2 = 5	3 = 5	4 = 5	--						
House or Apartment (6)	1 = 6	2 = 6	3 = 6	4 = 6	5 = 6	--					
School (7)	1 = 7	2 = 7	3 = 7	4 > 7	5 > 7	6 = 7	--				
Car (8)	1 = 8	2 = 8	3 = 8	4 = 8	5 > 8	6 = 8	7 = 8	--			
Bar or Club (9)	1 = 9	2 = 9	3 = 9	4 = 9	5 > 9	6 = 9	7 = 9	8 = 9	--		
Restaurant (10)	1 = 10	2 = 10	3 = 10	4 = 10	5 > 10	6 = 10	7 = 10	8 =10	9 = 10	--	
Party (11)	1 = 11	2 = 11	3 = 11	4 = 11	5 = 11	6 = 11	7 = 11	8 = 11	9 = 11	10 = 11	--

CURRICULUM VITA

Thom Taylor was born in Sioux Falls, South Dakota in 1981. The second son of Lynnette and John W. Taylor, Ph.D., he graduated from Brookings High School, Brookings, South Dakota in 1999. He subsequently attended the University of Minnesota, Duluth, where he graduated Magna Cum Laude with his Bachelor of Applied Sciences degree in Psychology in 2004. Between 2002 and 2004, Thom worked in the areas of sexual assault and sexual reproductive health as an intern and volunteer to the Program to Aid Victims of Sexual Assault as well as to Planned Parenthood of Duluth, Minnesota. Thom is currently a therapist at Family Service of El Paso where he continues to provide community mental health services for residents of the Paso del Norte region. At present, he is a research associate to a program initiative of the Paso del Norte Health Foundation where he works to provide improved substance use treatment and prevention services for individuals affected by or at risk of developing substance dependence.

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