AN ECOLOGICAL MOMENTARY ASSESSMENT ANALYSIS OF RELATIONS AMONG COPING, AFFECT, AND SMOKING LAPSE

by

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ABSTRACT OF THE THESIS

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This study used EMA data from smokers engaged in an earnest attempt to quit smoking to assess complex relations among coping, affect, and smoking. Analyses tested hypotheses about the main effects of coping and both mediators and moderators of coping effects on subsequent outcomes of interest (i.e., affect, coping effort, coping efficacy, and smoking behavior). Results of multilevel models indicated that coping does not improve negative affect within 4 hours of coping efforts, but that coping does improve positive affect and increase the odds of engaging in temptation coping in the short-term. Lapses were more likely to happen when recent coping was reported within 48 hours. None of the putative mediators of coping were predictive of later lapse risk as anticipated. Analyses also revealed that pre-quit coping practice moderated the effects of post-quit coping to deal with stressful events on later affect. Moreover, significant moderating gender effects were also found in these relations.

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Introduction

More than 440,000 deaths each year in the United States are attributed to tobacco use and smoking remains the leading preventable cause of illness and death (Centers for Disease Control and Prevention [CDC], 2005; National Center for Health Statistics, 2003). Yet, roughly 1 in 5 (roughly 44.5 million) American adults still smokes (CDC, 2004). Smoking exacts a toll not just on these individuals but on society as well; an estimated $96 billion are spent annually in direct medical expenditures and an equal amount in productivity loss (CDC, 2007). Although health care practitioners were slow to treat tobacco use initially[1], today up to 90 percent of smokers are asked about their smoking status during clinic visits and more than 70 percent receive cessation counseling (Quinn et al., 2005). Approaches to treating tobacco use have improved as well. Numerous treatments, including both counseling and medication treatments (e.g., bupropion SR, nicotine replacement therapy, varenicline) have been shown to double or triple the likelihood of achieving long-term abstinence in randomized clinical trials (Fiore et al., 2008).

Despite these improvements, cessation success rates remain low; only 3-5% of those who try to quit without any assistance successfully achieve complete abstinence (Hughes et al., 2004) and fewer than a third of people who use the best available treatments manage to stay abstinent from cigarettes for 6 months to one year (Fiore et al., 2008). This underscores the fact that smoking is addictive. The criteria for addiction emphasize loss of control over behavior, despite adverse consequences, as central to drug

[1] In 1995, smoking status was identified in only about 65 percent of clinic visits and only 22 percent of identified smokers received cessation counseling (Fiore et al., 2008).

dependence (Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, American Psychiatric Association, 1994). On the other hand, more than half of those who ever smoked have achieved complete abstinence (CDC, 2007) and the majority of successful cessation attempts are achieved through self-help (Fiore et al., 1990; 2008). This indicates that, even though it may not be easy, smoking cessation is an attainable goal for many. What then distinguishes successful quit attempts from those that fall short?

One factor that may contribute to cessation failure or relapse is stress and associated affective distress. Stressful events are common challenges faced by people attempting to quit smoking. Different drug motivation models propose various underlying mechanisms of addiction including the relation between stress (distress) and subsequent drug use behavior. Early models highlighted the central role of negative reinforcement learning in addictive behavior (Wikler, 1948). According to these models, relief from aversive physical or psychological states reinforces continued drug use. In other words, addicted individuals take drugs to avoid or to alleviate aversive withdrawal symptoms or distress, which is an almost universally reported reason for continued drug use (Baker et al., 2004; O'Brien, 1976; Wikler, 1980).

However, negative reinforcement models of drug dependence have encountered persistent criticisms (Lyvers, 1998; Robinson & Berridge, 1993). Various studies have failed to uncover consistent evidence that drug withdrawal effects predict drug use (e.g., Lamb et al., 199; McBride et al., 2006). Furthermore, self-reported cravings or urges (drug motivation) are often observed during or immediately following use, and are not always stronger during withdrawal (e.g., Childress et al., 1988; Meyer, 1988). These

inconsistent findings have led some scholars to question whether negative reinforcement is the central mechanism of addictive behavior and to propose alternative models of drug motivation, such as positive reinforcement and the incentive sensitization models (Robinson & Berridge, 1993; 2001). The finding that urges to use drugs may be stronger during or immediately following drug use supports positive reinforcement models of drug motivation that asserts that drug administration is maintained to achieve the pleasurable state that drugs induce (Stewart et al., 1984). On the other hand, Robinson and Berridge (1993) posit that drug motivation is maintained through neurochemical sensitization of drug "wanting" (increased incentive salience of drug stimuli with repeated drug use) whereas drug "liking" (subjective pleasure) can diminish after repeated drug use. However, neither of the theories adequately addresses the observed relations between stress and drug-taking behaviors.

In order to address the inconsistent findings in the literature, Baker et al. (2004) proposed a modification to the negative reinforcement model and asserted that the central motive for addicted behavior is escape or avoidance of negative affect[2], the motivational core of the withdrawal syndromes of diverse drugs. Baker et al. (2004) posited that negative affect is not only ubiquitous in withdrawal, but also acts as a drug motivational state. Addicted individuals become, through repeated substance–use-and-withdrawal cycles, more sensitive to the internal signals of the negative affect that emerges when drug intake is interrupted or delayed. According to the model, when such interoceptive cues are detected, routinized drug self-administration occurs without awareness or effort

[2] Negative affect, as defined in Watson and Pennebaker (1989), is a general dimension of subjective distress which subsumes a broad range of aversive affective states.

(Baker et al., 2004). This is consistent with the observation that many addicted individuals often report using drugs without experiencing conscious cravings or even without being aware of use behaviors (Tiffany, 1990). Additional research suggests that it is affective distress, rather than somatic symptoms of withdrawal that predicts drug use (Baker et al., 2004; Marlatt & Gordon, 1980; Piasecki, 2000).

These findings underscore the significance of affective states in drug motivation. Attention to the role of affect may help identify the motivational core of withdrawal across substances of abuse in addition to the established roles that physical withdrawal and distress play in the maintenance of addictive behavior. Furthermore, this theory also seems to account for the association between stressful events and lapse/relapse in those who are trying to stay abstinent; aversive affective states may mediate the effects of stress on subsequent drug taking behaviors.

Many addicted individuals report that their primary reason for drug use is to regulate negative affect or to cope with stress. This holds for the use of alcohol (Goldman, Brown, & Christiansen, 1987), tobacco (Wetter et al., 1994), cocaine (Jaffe & Kilbey, 1994), and marijuana (Schafer & Brown, 1991). It is possible that affective distress caused by external stressors can induce interoceptive cues of negative affect similar to those of withdrawal. This may lead addicted individuals to use drugs the same way they respond to nascent withdrawal symptoms (Baker et al., 2004; Marlatt & Gordon, 1980). In addition, various studies report a strong relationship between stress (external stressors) and smoking lapse and relapse (Shiffman et al., 1996; 1997; 2002; Shiffman, 2005). For instance, using ecological momentary assessment (EMA), Shiffman (2005) found that smoking lapses were preceded by rapid increases in negative affect in the

hours before the lapse (regardless of time since quitting), rather than tonic changes in mood over days. While negative affect in lapses can be due to tonic increases in withdrawal (Shiffman & Jarvik, 1976), such tonic influences appear inconsistent with the acute changes (increases) in negative affect preceding lapses observed by Shiffman (2005). Shiffman (2005) concluded that withdrawal may make smokers more vulnerable to everyday stressors that alter their affective states, ultimately promoting smoking.

Shiffman (1982) also found that most smokers reported that their lapses were preceded by stress and negative affect, a result replicated in other studies (Marlatt & Gordon, 1980; O'Connell & Martin, 1987). Similarly, a variety of within-subjects studies show that a third or more of smokers report that they lapsed during stressful events and negative affect states (see Kassel et al., 2003 for a review). However, Shiffman's (1982) retrospective study indicated that stressful experiences may be a precursor to highly tempting situations, but not necessarily to lapses or relapses. Data on the situations and affective states preceding relapse and temptation episodes were collected over a relapse-counseling hotline that participants were urged to call when they experienced relapse or a relapse crisis (temptation to smoke). The outcomes of temptation crises were associated with neither perceived stress levels nor changes in affect. In this study, the use of coping responses was the only predictor of temptation outcome; any coping response predicted successful resolution of the temptation without smoking. Later studies found additional evidence that coping responses are closely associated with temptation outcomes (Bliss et al., 1989; Curry & Marlatt, 1985; Shiffman, 1984).

Smoking cessation treatment programs have been quick to integrate such findings and typically aim to promote coping skills in response to smoking temptations as well as

warning would-be quitters about high-risk situations (Fiore et al., 2008; Lichtenstein & Glasgow, 1992). For instance, the Public Health Service Clinical Practice Guideline *Treating Tobacco Use and Dependence* (Fiore et al., 2008) recommends practical counseling that focuses on teaching problem-solving skills (e.g. learning cognitive coping strategies to regulate negative mood, reducing stress through changing lifestyle). Although Cognitive Behavioral Therapy (CBT) has been reported to be an effective treatment for substance dependence (e.g., for alcohol, Miller & Wilbourne, 2002; for cocaine, Maude-Griffin et al., 1998), to date, very little is understood about how this treatment works in relation to coping skills. For instance, Morgenstern and Longabaugh (2000) reported two main findings in a review of various alcohol treatment studies. First, coping skills associated with positive outcomes were not exclusively attributable to CBT and second, CBT-attributable increases in coping did not predict alcohol treatment outcomes. They concluded that cognitive-behavioral interventions, though often effective, do not reduce drug taking behaviors through their effects on coping skills. Similarly, another study on alcohol addiction treatment (Litt et al., 2003) established that, while the use of coping skills after treatment predicted outcomes, both interpersonal psychotherapy and CBT prompted equal increases in coping skills. This implies that explicit coping training vis-à-vis CBT is not necessary to attain more coping resources. This raises the following questions: Which components of CBT and other effective addiction treatments actually improve coping skills? How does coping with stressful events work to help quitting efforts if it does, and why, in some instances, does coping fail to predict better outcomes?

The role of coping in smoking cessation outcomes has been the focus of

considerable research (e.g., Bliss et al., 1989; Brown et al., 1990; Katz & Singh, 1986; Litt et al., 2003; O'Connell et al., 1998; Shiffman, Gnys et al., 1996; Shiffman, Paty et al., 1996; Stone & Shiffman, 1994). Bliss et al. (1989) conducted follow-up interviews with smokers one month after their target quit date to gather detailed information about lapses (for lapsers) or temptations (for abstainers). In this retrospective study, data suggested that the number of temptation-coping strategies used positively predicted abstinence. Similarly, a community intervention trial (Stoffelmayr et al., 2003) collected information on the antecedents of lapses and/or temptations through predetermined scheduled phone calls (1, 3, 7, 14, 30, and 60 days after the quit date) from smoking cessation counselors. This trial demonstrated that 7-day point prevalence abstinence at the six-month follow-up was associated with the average number of coping strategies used rather than the average number of temptations reported. While there was no difference in the number of temptations between those who lapsed and remained smoke-free at the six-month follow-up, on average, smoke-free-individuals employed more coping strategies to deal with urge situations.

Although much research supports the consensus that stressful events and coping efforts to deal with temptations predict cessation outcomes, the results of studies that compare the effectiveness of specific coping strategies remain inconclusive. Certain coping strategies have been shown to be effective (e.g., an acceptance coping strategies in a retrospective study for weight loss, Forman et al., 2007; self-reward and encouragement in a retrospective smoking cessation study, Stoffelmayr, et al., 2003; cognitive coping strategies in a smoking cessation study using EMA, Shiffman, 1996). Other coping strategies have been shown to be ineffective (e.g., using will power in a retrospective

smoking cessation study, Shiffman, 1982) in particular populations with respect to enhancing self-control. Yet other studies, both a retrospective and an EMA study (e.g., Bliss et al., 1989; O'Connell, 2007, respectively), have found that there are no differences in the effectiveness of specific coping strategies used to deal with temptations. That is, the use of cognitive and behavioral coping strategies seemed to have equal success rates in smoking cessation treatment. Moreover, while retrospective studies conducted by Curry and Marlatt (1985) and Shiffman (1984) found that combining cognitive and behavioral strategies improved their effectiveness beyond the number of coping responses, data from Bliss et al. (1989) suggest that it is not the combination of strategies used per se but the total number of coping responses to a temptation that increases coping effectiveness. Coping strategies may not be as essential as they are thought to be; the coping effort itself may be the crux of the matter.

As this brief review illustrates, there are considerable inconsistencies across studies and many unanswered questions with regard to coping benefits. For instance, to what extent the number of coping efforts may reflect motivation and determination to quit is unclear. It is possible that frequent coping may play a mediating role between one's momentary motivation to quit and reduced lapse/relapse risk while the level of motivation could independently affect both occurrence of coping efforts and maintained abstinence. Although data from previous studies indicated that the coping-abstinence relation persisted when motivation was controlled, extant findings remained inconclusive. Furthermore, the research above focused mainly on the effect of coping on outcomes (e.g., staying abstinent from smoking or drinking) and did not assess affective changes following coping efforts. Thus, the extent to which coping effectively alleviates affective

distress has not been shown to mediate coping effects on abstinence. Moreover, it is crucial to note that most of the studies discussed above relied heavily on retrospective self-reports and between-subjects analyses. Stone et al. (1998) cogently demonstrated the potential bias in retrospective coping assessments by comparing 48-hour retrospective and momentary coping reports using EMA. The correspondence between the two assessments was low; in retrospective assessments, cognitive coping was likely to be underreported while behavioral coping was over-reported, relative to EMA reports. Also, when coping efforts are assessed once per subject, the results from between-subjects comparisons only permit us to conclude that there is a different outcome in people who use a certain coping style and people who do not use that particular strategy. Such differences may reflect stable individual differences rather than the effects of coping per se. On the other hand, within-subject designs allow us to conclude that effects of coping are attributable not to individual characteristics, but to the coping effort itself or, at least to situation-specific factors. While much of the discrepancy in these results may be due to inconsistent methodologies (e.g., retrospective assessment vs. EMA), the discrepant results in studies using EMA (e.g., O'Connell 2007 and Shiffman 1996) indicate that there may be more than simple differences in assessment methods leading to diverse results in this literature.

Research to date has yet to demonstrate conclusive findings on coping and smoking cessation success. The current incomplete state of the evidence may partially be due to the inconsistent methodologies used across studies. At the same time, previous research on coping focused mainly on post-quit coping efforts and no studies have yet examined the role of coping training pre-quit in cessation efforts. Just as we cannot drive

without sufficient practice, we are unlikely to cope effectively without training. Quitting smoking is for most a difficult task which requires tremendous effort and self-control as well as motivation and persistence. The fact that coping requires skill and effortful processing leads one to ask: if one has to exercise sustained self-control in order to refrain from smoking, how does exerting extra effort to cope with stress affect one's cessation effort? To what extent is effortful coping beneficial or harmful? Can a seasoned coper exert additional self-control effortlessly relative to those with less practice prior to a quit attempt?

The self-regulatory strength model (Heatherton & Baumeister, 1996; Muraven & Baumeister, 2000) asserts that the resources for self-control are limited and consequently, self-control failures are more likely to follow earlier self-control efforts that have exhausted available resources. Self-control is the conscious effort to alter or inhibit one's competing behaviors, thoughts, desires, or feelings. Not all effortful and difficult behaviors require self-control, however. Solving very difficult math problems entails much effort, yet it typically does not involve overriding or inhibiting behaviors or emotions, whereas affect regulation and attempts to quit smoking or to stay sober after alcohol addiction treatment require both effort and self-control. Baumeister et al. (2000) posit that coping with stress may increase the likelihood of failure in subsequent self-control efforts such as abstaining from smoking or drinking. Various experimental studies (e.g., Muraven & Baumeister, 2000; Muraven et al., 2002; Vohs & Heatherton, 2000) suggest that diverse spheres of self-control rely on the same limited resources and that exercising self-control demands in one domain may affect the capacity to exert self-control in another. Some studies have shown that depletion effects are not associated with

mood or distress, thus supporting the assumption of the strength model that negative affect or learned helplessness is not what impairs self-control. In studies that used mood regulation manipulations (i.e., by asking participants to suppress induced emotions vs. act naturally) to investigate self-control resource depletion (e.g., Muraven et al., 2002; Vohs & Heatherton, 2000), individuals' subsequent performance on self-control tasks (e.g., amount of alcohol consumption during a taste-rating task) differed depending on whether they had successfully inhibited their reactions (emotions) but not on the initial level of distress or negative affect induced by the affect manipulation. Thus, it appears as though attempts to manage distress influence performance in a manner independent of the level of distress experienced. In the context of a smoking cessation attempt, this may mean that it is not the severity of withdrawal distress that is paramount in increasing lapse/relapse risk, but rather depletion of resources deployed to alleviate distress and inhibit smoking behavior that influences risk.

A premise of the self-regulatory strength model is that the outcome (success or failure) of self-control efforts depends on the momentary availability of self-control resources. For instance, dieters are at greater risk of eating than non-dieters following a challenge requiring self-control simply because dieters have already been exerting self-control, thus leaving few resources left for subsequent self-control efforts (Vohs & Heatherton, 2000). This concept may readily apply to smokers who are trying to quit. Cessation failure or relapse may be more likely to occur when few self-control resources are available to deal with temptations or urges. For example, exercising additional self-control to cope with stress or to improve negative affect may have deleterious effects on self-control to maintain abstinence. Trying to improve one's mood may affect subsequent

cessation efforts. Indeed, a study by Muraven et al., (2002) found that suppressing emotions or thoughts increased alcohol intake in an experimental setting. In addition, in the face of distress, people tend to prioritize short-term affect regulation (improving NA) over other self-control goals (Tice et al., 2001). As such, the cessation effort may be jeopardized due to coping efforts to deal with distress, particularly if people see drug use as an efficient way to relieve distress (Baker et al., 2004).

Other behavioral problems have also been linked to self-control resource depletion, including overeating (Vohs & Heatherton, 2000), intellectual underachievement (Schmeichel et al., 2003), and impulsive aggression (DeWall et al., 2007). These findings suggest that there may be hidden costs of effortful coping like those advocated in smoking cessation counseling. Frequent or intensive coping may lead to unfavorable outcomes in situations where coping has been repeatedly used because one's self-control resources may be exhausted. Thus, prolonged or intensive efforts at self-control (i.e. coping) may harm one's ability to manage subsequent temptations to smoke.

However, as a muscle can be strengthened through exercise, the stamina of one's self-control can also be improved through repeated practice (Muraven et al., 2007). Muraven et al. (2007) found that exercising self-regulation for as little as two weeks minimizes the depleting effects of self-control in laboratory tasks (i.e., not expressing biases toward others). These self-regulation exercises (e.g. not using a dominant hand, refraining from often-used phrases) were irrelevant to the target self-control task. Thus, it may be reasonable to expect that those who frequently practice coping with various stressful events prior to quitting smoking will have better chances of remaining abstinent

in the face of stress. Palfai (2006) posits that with sufficient practice, self-control can become an automatic process that does not demand much conscious effort. Palfai (2006) underscores the utility of self-control for relapse prevention. Well-practiced self-control efforts, including regulating negative affect and refraining from addictive behaviors, may exhaust fewer cognitive resources than novel self-control efforts, which in turn may increase the odds of successful execution of self-control. Practice is likely the most direct way to enhance the automaticity of self-control. This may partially explain why a history of multiple quit attempts predicts subsequent success in quitting (Fiore et al., 2008).

Taken together, the findings reviewed above suggest that although the sudden use of unpracticed coping may be detrimental to a quit attempt due to short-term depletion of self-control resources, learning and exercising coping through self-control prior to quitting could be beneficial to both stress management and the cessation effort. Should this prediction hold, then its clinical implications would be important. For instance, smokers could be encouraged and given opportunities to practice coping (self-control) in the face of stressors *prior* to the target quit day. Encouraging individuals who are trying to quit smoking to use novel coping strategies without sufficient preparation and training may work negatively with regards to smoking cessation.

Shiffman (2005) conducted one of the few smoking cessation studies to test the self-regulatory strength model. Negative affect may promote smoking and lapses not solely due to its role as stimulus and drug motivational prod but also due to its effect on cognitive resources. Shiffman's (2005) results indicated that negative affect may moderate the effects of coping on cessation outcomes. In this study, the lapse rate after coping (i.e., failure rate of coping efforts) increased with rising negative affect. Negative

affect did not deter one from trying to cope with temptations, but people with high negative affect were less able to cope with temptations effectively, and lapsed despite coping efforts. In another study, Katz and Singh (1986) argued that what distinguishes successful quitters from relapsers is greater self-control and coping skill in general. Such skills not only help to manage daily stressors but also prevent stress from interrupting the effort to quit smoking. A separate study for alcohol addiction treatment (Brown et al., 1990) demonstrated that psychosocial stress, both pre- and post-treatment, predicted increased risk of drinking relapse. This result supports Brown et al.'s (1990) initial hypothesis that severe stressful events after treatment precipitate relapse through the draining of individuals' coping repertoires, especially in vulnerable individuals (i.e., those with pre-existing chronic stress or under severe, acute stress). These findings suggest that better or larger repertoires of coping skills may be crucial for minimizing the risk of relapse, and that excessive coping demands may have a deleterious impact on recovery.

Multiple drug motivation models attempt to explain reasons for lapses and relapses. Such models typically focus on the processes driving addiction and attempt to explain continued drug use in relation to the mechanisms of addiction. Although the roles of coping, stress, and negative affect have been explored within such frameworks, the reasons for lapse and relapse in relation to stress and coping remain unclear: Does coping with stress help to maintain the cessation effort? If so, to what extent and under what conditions is such coping beneficial? In the current study, I attempted to examine how coping with stress affected smoking cessation efforts and abstinence using the self-regulatory strength model (Baumeister & Muraven, 2000). I predicted that when one copes with both stress and temptation, the likelihood of cessation maintenance would

depend on: (1) the *efficacy* of coping (as measured by affect improvement), and (2) prior coping *experience* (as measured by frequency of pre-quit coping with stress). Changes in both negative affect (decreased) and/or positive affect (increased) were used to assess one's affective improvement, as successful coping efforts may influence the ongoing cessation effort in the face of stressors not only by ameliorating negative affect, but also by increasing (or maintaining) positive affect. Negative reinforcement models identify anhedonia (e.g., lack of positive affect) as an aversive state that leads to drug taking behavior (Baker et al. 2004). In other words, sustained or increased positive affect may indicate that such an aversive state has been avoided or eliminated, and in turn, predict better cessation outcomes.[3] Furthermore, a recent study by Tice, Baumeister, & Muraven (2007) found that positive affect (induced by comedy videos or surprise gifts) counteracted the depleting effect of initial self-control efforts (e.g., suppressing forbidden thoughts, resisting temptation to eat cookies) on subsequent self-regulation (e.g., persistence on unsolvable puzzles or drinking bad-tasting drinks) across 4 experiments. They concluded that positive affect counteracted depletion while induced sad mood did not predict any change in subsequent self-control behavior. Based on these findings, it is plausible that increased positive affect after coping efforts may not only reflect successful and efficacious coping attempts, but also indicate the offsetting of the depletion of cognitive resources.

[3] Moreover, the dynamic model of affect (DMA) proposed by Zautra, Potter, & Rieich (1997) posits that stressful events may narrow the affective space between negative and positive affect because uncertainty caused by stressors may motivate individuals to focus on stress-related emotions (i.e., Negative Affect). Other research (e.g., Zautra, Johnson, Davis & Reich, 2005) suggests that the maintenance of positive affect during stressful events reflects resilience to stress. As such, it may be that successful coping efforts result in increasing positive affect which promotes smoking cessation by reducing one's focus on negative affect and stressors.

The current study used data from a double-blind, randomized, placebo-controlled clinical trial of bupropion SR and individual counseling with adult daily smokers motivated to quit smoking (McCarthy et al., 2008). Participants' smoking and coping behaviors and changes in their affect, thoughts, and possible withdrawal symptoms were assessed with multiple ecological momentary assessment (EMA) (Stone & Shiffman, 1994) reports collected using electronic diaries both pre-and post quit. Using EMA data allows us to analyze prospective day-to-day, hour-to-hour variation in individuals' experiences. Participants provided data in near real-time regarding the occurrence of stressful events and whether they used cognitive, behavioral, and/or acceptance strategies to cope with those incidents in random reports administered throughout the waking day.

Study Hypotheses

The model of relations among coping efforts, affect, and smoking lapse likelihood tested in the study is shown in Figure 1. I attempted to test a complex set of hypotheses regarding the short-term effects of coping with stressful life events on affect and behavior in the context of an attempt to quit smoking permanently. First, EMA data were used to determine whether coping with stress prospectively predicted change in the likelihood of a smoking lapse over the 48 hours following the coping effort. The results of this test may support the prevailing notion that coping with stress is protective against smoking lapses, or may indicate that coping with stress may increase lapse risk, presumably due to depletion of limited self-control resources, at least among those who do not practice frequent coping prior to attempting to quit smoking. That is, the relation between coping and later lapse may be moderated by prior coping experience (Figure 1 path m_3), as

suggested by the self-regulatory strength model described above. These data may help identify whether promoting stress coping in smoking cessation counseling is likely to have beneficial or harmful effects overall, or for particular individuals.

Second, to add to the literature regarding the effects of coping efforts on subsequent affect, I first examined the effect of stress coping (vs. no coping) on affect over 4 hours (see Figure 1, paths a_1 *and* a_2,). I predicted that coping would be associated with improved affect (reduced negative affect and increased positive affect, estimated separately) over 4 hours, relative to reports in which no coping was reported following the occurrence of a stressful event. I further hypothesized that these changes would be more apparent when individuals had prior stress coping experience. That is, I predicted that pre-quit stress coping frequency would moderate the effect of coping on later affect in the post-quit period (Figure 1 path m_1 and m_2). Results of this analysis may help clarify the efficacy of coping efforts as affect regulation behaviors in a within-subjects analysis and extend the literature in this area by using EMA to further understand the temporal relations between coping and subsequent affect. Moreover, a pre-quit individual difference in coping was incorporated as a moderator to evaluate the extent to which coping efficacy was influenced by pre-quit coping training.

I next investigated the relation between stress coping (vs. no coping) and subsequent coping efforts with temptations to smoke (see Figure 1, path a_3) in an effort to test predictions of the self-regulatory strength model using EMA data collected during the course of an ecologically valid behavior change effort. I tested whether or not the likelihood of engaging in effortful temptation coping differed within 4 hours of a previous stress coping report, when compared against situations in which no stress coping

was executed despite the occurrence of a stressful event. (The occurrence of stressors reported following the index stress coping effort was statistically controlled.) I predicted that the effect of stress coping on subsequent coping attempts with temptations would be influenced by individuals' prior stress coping experiences (Figure 1, path m_4). This test may add to existing literature by clarifying the influence that coping efforts have on subsequent coping efforts and by taking into account possible interactions between pre-quit individual differences and stress coping sequelae. Furthermore, I examined the extent to which the occurrence of temptation coping following active stress coping post-quit mediated the relation between stress coping and smoking lapse (Figure 1, paths a_3 and b_3). I predicted that effortful temptation coping (vs. no coping) would be associated with decreased subsequent lapse risk within individuals, but that such coping would be less likely following stress coping due to depletion of self-control resources. Therefore, I hypothesized that the relation between stress and subsequent lapse risk would be mediated by a reduced likelihood of engaging in temptation coping.

To determine whether coping with stress was associated with lower subsequent temptation-coping efficacy, as predicted by the self-regulatory strength model, I also examined the effect of stress coping (vs. no coping) on the efficacy of subsequent temptation coping (Figure 1, path m_6). I predicted that stress coping (vs. no coping) would interact with later temptation coping to influence subsequent lapse risk. I hypothesized that temptation coping after stress coping would be less effective than when not preceded by a stress coping effort, and would increase subsequent lapse risk. I also hypothesized that individuals' prior stress coping experience would moderate the relation between stress coping and the efficacy of subsequent coping attempts with temptations

(Figure 2, path m_5). This analysis may help elucidate the possible effects of stress coping on the efficacy of subsequent coping efforts within subjects, and the potential impact of individual differences on these relations.

I explored the extent to which changes in affective state (negative and positive affect) after active stress coping post-quit mediated the relation between stress coping and smoking lapse. I predicted that coping would decrease negative affect and increase positive affect and predicted reduced risk of lapsing following stress coping attempts. Thus, I predicted that the relation between stress coping and subsequent lapses would be mediated by intervening changes in negative affect and positive affect.

In addition, I explored the differential effects of specific coping strategies (i.e., cognitive, behavioral, and acceptance-based coping) as the hypotheses above may apply to various coping styles to different degrees. Although all of the coping styles assessed in this study involved self-control, the extent to which each coping style required cognitive control is uncertain and may vary. Moreover, the use of behavioral coping strategies may reflect one's stronger momentary motivation simply because cognitive coping (e.g., using thoughts, imagery, etc.) or acceptance coping may take less time and physical effort compared to behavioral coping (e.g., taking a walk, deep breath, etc.).

In summary, results from the proposed study may add to the literature regarding the role of coping in smoking cessation efforts by examining multiple short-term effects of efforts to cope with stress on affective and behavioral outcomes using data collected within-subjects in near real-time. In this way, the current study may help clarify the complex effects of effortful coping on important outcomes and may generate information that will be useful in treatment planning in the future.

Method

Participants

Data used in the current study were collected for a double-blind, randomized, placebo-controlled clinical trial of bupropion SR and individual counseling for smoking cessation treatment (McCarthy et al., 2008). Participants were adult daily smokers (age 18 years and older) recruited in the Madison, Wisconsin area via mass media calls for volunteers. Participants completed a screening process with the following inclusion criteria: smoking a minimum of 10 cigarettes per day, having an expired carbon monoxide (CO) level of 10 parts per million or greater, motivation to quit smoking of at least three on a 4-point scale, and willingness to fulfill study requirements. Exclusion criteria were as follows: serious psychiatric conditions (i.e., bipolar disorder or psychosis), current depression, and contraindications to use of bupropion SR (e.g., uncontrolled hypertension, history of seizure disorder, history of eating disorders, current heavy drinking, risk of pregnancy, or current breast feeding). Participants were excluded if they scored above 16 on the Center for Epidemiologic Studies Depression scale (CES-D; Radloff, 1977), except when a licensed clinician deemed that symptoms were not due to clinical depression after a brief interview. This exclusion criterion was included to prevent potential exacerbation of preexisting depression symptoms caused by a smoking cessation attempt.

A total of 463 participants who met all criteria were enrolled in the study and attended the first study visit. For the current analysis, 13% of enrolled individuals (n=60) who dropped out of the study prior to the quit date (and, therefore, did not make a quit attempt) were excluded. Those who never reported stressful events in their daytime

reports (n=24, 5.2% of the enrolled sample) and who never reported stress coping (n=7, 1.5% of the enrolled sample) were excluded (see Figure 2). Demographic characteristics of the 372 individuals included in the proposed analyses are shown in Table 1.

Measures

Baseline Assessment

Participants were asked to provide demographic information (see Table 1) and answer baseline self-report measures designed to assess: depressive symptoms using the CES-D, smoking history, nicotine dependence using the Fagerström Test of Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991), nicotine withdrawal using the Wisconsin Smoking Withdrawal Scale (WSWS; Welsch et al., 1999), affect (during the past week) using the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988), and the stress reactivity using Negative Emotionality Subscale (NES; Tellegen, 1998) from the Multidimensional Personality Questionnaire at the baseline session, in the order listed above.

The FTND consists of six items (e.g., "How soon after you wake up do you smoke?") and has a maximum score of 10. A higher score indicates greater physical dependence on nicotine. A score of 5 indicates medium dependence, while 6 to 7 is considered high dependence (Fagerström, Heatherton & Kozlowski, 1992). The internal consistency of the FTND is fair (Cronbach's $\alpha = .61$) (Heatherton et al, 1991). Other longitudinal studies found high test–retest correlations for the FTND ranging from .85 in .88 (Etter et al. 1999; Pomerleau et al. 1994).

The PANAS scale developed by Watson et al. (1988) is a self-report measure of affective state rated on a 5-point scale (ranging from 1 = very slightly to 5 = extremely) during a specified period of time (i.e. moment, today, past few days, past few weeks, year, general). This scale consists of 20 questions of which ten relate to positive affect and the remaining ten to negative affect. Watson et al. (1988) reported strong internal consistency for the scale (α = .84 to .90). A recent study using a non-clinical sample (Crawford & Henry, 2004) also demonstrated that the PANAS is reliable and a valid measure of subjective affect with Cronbach's α (internal consistency) of .89 for positive affect and .85 for negative affect.

The WSWS is a 28-item scale comprised of seven subscales (i.e., anger, anxiety, sadness, concentration, hunger, sleep, and craving) that tap the central elements of the nicotine withdrawal syndrome. Welsh et al. (1999) reported that internal consistencies ranged from α = .75 to α = .93 for the subscales and α = .90 for the total score. Validity assessments also supported the WSWS, showing relatively high correlations between the WSWS negative affect scales with the negative affect items of the PANAS (r = .46–.59), and significant relations between WSWS scores and smoking outcomes (Welsh et al., 1999).

The Negative Emotionality Subscale (NES) was designed to assess trait negative affectivity comprising 14 items that tap into nervousness, apprehension, sensitivity, and emotional liability. High scores on this scale reflect frequent (chronic) experience of negative affect. Research supports the psychometric properties of the NES (coefficient α = .82, Watson, Clark & Carey, 1988; 12-week retest r = .72, Watson & Pennebaker, 1989).

Each of these baseline measures was entered as a subject-level covariate in the multilevel models described above. Baseline covariates were only retained in models, however, if they were significantly related to occasion-level coefficients. Nonsignificant covariates were trimmed from models in favor of parsimony.

Ecological Momentary Assessment

Participants' self-reported thoughts, emotions, withdrawal symptoms, temptations, coping with temptation, stressful events, coping with stress, and smoking behaviors were assessed (in this order) via palmtop computers, or Electronic Diaries (EDs). EDs (Palm Vx Palmtop Computer, Palm, Inc., Santa Clara, CA) were programmed by invivo data Inc. (Pittsburgh, PA) to administer multiple ecological momentary assessment reports daily for two weeks pre-and 4 weeks post-quit. During the waking day, participants were prompted to complete 4 to 7 momentary reports (random reports) at pseudo-random times separated by at least 30-minute intervals. The reports took approximately two minutes to complete and were time-stamped to indicate when they were completed.

Random reports assessed the occurrence of stressful events (yes/no) since the last report, the type of stressful events reported (i.e., marital, family, other person, work/school, finances, legal, health, and trauma), and whether participants tried to cope with these incidents (yes/no). Participants who endorsed coping attempts were asked to identify whether they used cognitive, behavior, and/or acceptance coping strategies. Furthermore, the number of strong temptations and/or urges since the last report was assessed (0-99), and participants who reported temptations were asked whether they tried to cope with the temptations (yes/no) and how they coped (thoughts, behaviors, acceptance, willpower). Finally, the number of cigarettes smoked since the last report

was assessed (0-20 cigarettes). Random reports also included questions derived from the PANAS and the WSWS assessing affect and withdrawal symptoms respectively. Two highly correlated P-PANAS items ("interested" and "enthusiastic") (r=.83; McCarthy et al. 2008) were averaged to yield a positive affect summary score. Items from the WSWS assessed during random reports included:"tense or anxious," "sad or depressed," "urge to smoke," "bothered by desired to smoke," "hard to pay attention," and "thinking about food a lot." Factor analyses reported by McCarthy et al. (2008) suggest that urges and thoughts about food did not load on the same factor as the negative affect and cognitive items. For the current study, I used the average of the items regarding anxiety and sadness (r = .45) as a measure of momentary negative affect. The timeframe of these questions was just before the prompt and participants rated their agreement on an 11-point scale ranging from 1 (No!!) to 11 (Yes!!). An EMA study conducted by McCarthy et al. (2006) used a similar measure to assess negative affect; the negative affect score reflected the mean of six items from the WSWS related to anger, anxiety, and sadness. McCarthy et al. (2006) demonstrated that negative affect scores were significantly associated with point-prevalence smoking status three months post-quit (p = .03) and significantly correlated with stressful event reports (p = .001). As such, previous research supports the validity of very brief adaptations of WSWS items for EMA use.

For each dependent variable (i.e., positive affect, negative affect, temptation-coping), I used the next report within 4 hours (t_1) of the index coping episode (t_0) to assess immediate changes associated with coping. I selected a 4-hour interval because the majority (83%) of random reports in a given day were recorded within 4 hours of a previous report (M=3.37 hours, $Median$= 2.18, SD=2.13). Analyses focused on the next

report allow us to detect immediate changes in affect and occurrence of temptation coping following a stress coping episode. Furthermore, the variables above were analyzed as putative mediators between stress coping and smoking outcomes (smoking vs. no smoking) within 48 hours (t_2).

Lapse was assessed by determining whether any smoking was reported in the 48 hours following an index stress coping episode by aggregating the sum of the number of cigarettes smoked across all random reports completed within the 48-hour window specified. Smoking at the time of the index coping episode (t_0) and during the 4-hour window of mediator assessment (t_1) were computed as well and included as control variables so that analyses predict the likelihood of new lapses to smoking within 48 hours (t_2) following coping.

Procedures

All study procedures were approved by an Institutional Review Board. Interested volunteers responding to mass media were first screened for eligibility over the telephone. Eligible individuals were invited to a group orientation session at which written informed consent was obtained after prospective participants received with a detailed description of the study. Additional screening such as CO testing was performed at the orientation session and a physical exam was conducted at the first office visit. Participants were enrolled in the study after passing this exam.

Participants were randomized at enrollment into one of 4 cells in a 2 (active drug v. placebo) x 2 (counseling v. no counseling) factorial design. They received either active or placebo bupropion sustained release (SR) beginning one week before the quit day and

lasting a total of 9 weeks with either eight sessions of brief (10-minute) individual cessation counseling or a no counseling, control condition (medication management and assessment only). Participants who did not receive counseling had roughly 80 fewer minutes of contact with staff since they had slightly shorter sessions than did those assigned to counseling. Research staff who screened and enrolled participants were blind to the experimental condition to be assigned. Placebo and active medications were indistinguishable by shape and color, and packaged in identical containers labeled only with participant identification numbers prior to participant enrollment. Staff who interacted with participants were unaware of participants' medication condition. Counseling condition was known to both research staff and participants.

Participants attended a total of 13 study visits, five office visits (including the baseline assessment session) in the three weeks prior to the quit date, and another eight office visits over the eight weeks following the quit date – at days 0, 3, 7, 14, 21, 28, 42, and 56 post-quit. Participants carried EDs from day -14 to 28, relative to the quit date. EDs were programmed to collect 4–7 momentary reports at pseudo-random times (not within 30 minutes of a previous report) daily. After all visits, participants received monthly follow-up phone calls through 1-year post-quit. CO testing was conducted at all visits and a blood sample was collected to assess cotinine (the first metabolite of nicotine) levels at baseline and again at the end of treatment for subjects who reported abstinence. Maximum remuneration for attending office visits, including follow-up visits was $200, and payment was contingent upon return of the ED at the end of the recording period.

Final Sample

For the current study, 372 (80.3% out of 463 enrolled) participants who attended the quit day visit and reported at least one stressful event and one stress-coping effort were included in the analyses (Figure 2). During the post-quit period, 372 participants in the final sample provided 37,067 random report records. The excluded sample consisted of:18 participants in the placebo, no counseling condition; 28 in the placebo, counseling condition; 24 in the active, no counseling condition; and 21 in the active, counseling condition while the included sample contained 95, 93, 92, 92 participants for each treatment group respectively. There was no significant difference in distribution across conditions between the sample selected versus excluded in the current analysis, $\chi^2(3, N = 463) = 2.10$, $p = .552$. The 91 excluded participants reported smoking significantly more cigarettes per day ($M = 23.95$, $SD = 10.97$) than those retained ($M = 21.44$, $SD = 10.26$, $t(461) = 2.06$, $p = .04$). The excluded sample also had higher total scores on the FTND ($M = 5.63$, $SD = 2.46$) than those who were included in the analyses ($M = 4.98$, $SD = 2.33$, $t(455) = 2.31$, $p = .021$). The gender composition of the included and excluded samples also differed significantly, $\chi^2(1, N = 463) = 6.42$, $p = .011$. The percentage of female participants was higher in the included sample (198 out of 372, 53.2%) than in the excluded sample (35 out of 91, 38.5%). The percentage of reported stressful events in the two weeks prior to quitting was marginally higher in included participants ($M = 9.06$, $SD = 9.33$) than in excluded participants ($M = 6.87$, $SD = 9.72$, $t(437) = -1.84$, $p = .067$). The excluded and included participants did not differ in terms of age, minority status, years smoking, CO level, or number of past quit attempts (all $ps > .05$). Actual sample sizes for the analyses varied from 320 to 347 due to missing data and lack of variability across

reports among some cases that made it impossible to estimate within subject effects for these individuals.

Data Analysis

The within-subject, repeated measures design of this study renders the data suitable for multilevel modeling (Raudenbush & Bryk, 2002). The data used in this study consisted of repeated measures (reports) that are likely correlated within the same individuals, given that a report of the same individual is more similar to his/her own previous reports in comparison to those of others. In multilevel modeling, these similarities within individuals are taken into consideration and it is possible to investigate whether and to what extent relations between variables (at the level of the observation, level 1) vary across individuals (level 2; Raudenbush & Bryk, 2002). In this study, random reports (i.e., reports of stressful events, stress-coping, temptation-coping, positive and negative affect, and smoking) that made up the first level of the data were nested within individuals at the second level. This study aimed to assess coping associations with later affect and smoking within subjects. Data were analyzed using Hierarchical Linear Modeling (HLM) Version 6.04 software (Raudenbush, Bryk, & Congdon, 2007) to work with a series of multilevel random coefficient models. HLM 6.04 is able to analyze linear and nonlinear outcome variables.

The medication and counseling conditions were included as time-invariant covariates at the individual level in order to control for possible effects of medication and counseling on outcomes at level 1 in every model. Three dichotomous variables included: counseling (0=counseling, 1= no counseling); medication (0= mediation, 1= no

medication); interaction (0 = neither counseling nor medication, 1= counseling & medication). Baseline level-2 covariates including gender, nicotine dependence (as measured by the FTND), and positive and negative affectivity (PANAS and NES) were also included as predictors of intercept values. I also explored the influence of gender (0=male, 1=female) on the relations between stress coping and the putative mediators and lapse risk if any of these level-2 covariates were not related to the dependent variable, they were pruned from the model to enhance parsimony.

Regression coefficients within-subjects (level 1) were allowed to vary across individuals (level 2), by specifying random effects, if doing so increased model fit (by increasing the log-likelihood estimate for the model and reducing model deviance). If fully random models did not converge, some coefficients were fixed (e.g., the smoking covariate coefficient) until the model converged. In non-linear models predicting the likelihood of smoking lapse, a Bernoulli distribution was specified, as smoking was coded as dichotomous (0 = abstinent, 1=smoked at least one cigarette). The same specification was used for the model with temptation coping outcome (0=no coping, 1=coping at least once).

In order to establish the relations between the putative mediators and lapse risk, necessary for the proposed mediational model, coping relations with mediators were assessed (see Figure 1, *a* paths), and the putative mediators were tested as predictors of smoking outcomes in the next 48 hours (t_2) (see Figure 1, *b* paths). Inclusion of the putative mediators (e.g., negative affect) in the model was predicted to reduce the direct relation between coping and smoking outcomes and to improve the overall model fit (see Figure 2, path *c'*). Continuous mediators (i.e., positive and negative affect) were centered

around the individual means prior to entry in models predicting smoking lapse, so that when all other predictors are zero, estimated coefficients reflect the probability of lapsing at the individual's average level of positive and negative affect. Mediational hypotheses were rejected if: coping was not significantly related to the mediator, the mediator was not predictive of lapse, or the direct effect of coping on lapse was not reduced when the mediator was included in the model.

The hypothesis regarding the moderating influence of coping experience on coping efficacy in terms of improved affect, increased temptation coping, and decreased lapse risk was assessed by including pre-quit coping count at level 2 of the model as a predictor of level 1 stress coping regression coefficients. Significant coefficients for coping experience at level 2 indicate that pre-quit coping experience significantly predicted the strength and/or direction of association between stress coping and subsequent mediator or lapse variables.

Results

Lapse Risk Over 48 Hours

First, I examined whether stress coping prospectively predicted a change in the probability of a lapse over the 48 hours following the coping effort. Stressful event occurrence, stress coping, and smoking at the index report (t_0) were included as predictors in the model. The occurrence of stressful events and coping efforts to deal with stressors over the next 48 hours (between t_0 and t_2) following stress coping at the index report (t_0) were included as time-varying covariates in order to control for the accumulated effects of stressful events and active coping attempts on smoking lapses. Only the model intercept was allowed to vary across subjects because freeing additional parameters resulted in a failure to converge. Results (Table 2, top panel) indicated that neither stressful events nor stress coping at t_0 significantly predicted lapse likelihood 48 hours later. The cumulative count of stressful event reports over the 48 hours after the index report, and the occurrence of any stress coping (coded dichotomously) between t_0 and t_2 were both associated with an increase in the odds of lapsing within 48 hours of the index report, however. Smoking at t_0 also predicted later smoking, as expected.

Relations between stress coping and lapse risk did not vary as a function of pre-quit coping experience (*ps*>.05), contrary to my hypothesis. The number of stressful events and stress coping efforts reported in the two weeks prior to the quit date did not (t_0 or t_2) moderate stress coping-lapse relations in the model tested. The only level-2 variable that was significantly related to lapse likelihood over 48 hours following a random report was medication condition. Intercept values were significantly lower, indicating significantly reduced probability of lapsing in the absence of stress, coping, or prior

smoking, among those receiving active bupropion SR (vs. placebo). Although age and gender were retained as level-2 explanatory variables for the intercept and t_2 stress coping predictor, respectively, due to their marginal relations with lapse risk, they did not meet our criterion for statistical significance ($p<.05$).

Negative Affect within 4 Hours

Next, I tested the effect of stress coping (vs. no coping) on negative affect at the next report within 4 hours (t_1) (see Figure 1, path a_1). Previous (t_0) negative affect was included as a control variable in the model in order to assess change in negative affect following new bouts of stress and coping. Stressful event occurrence and smoking were also assessed at t_0 and at the next report within 4 hours (t_1), and were included as time-varying covariates in order to control for effects of stress and smoking on affect. Moreover, recent stress coping efforts were assessed at t_1 and included as a predictor of affect in the current model.

Negative affect at t_0 was a strong, positive predictor of negative affect at t_1. The intercept and negative affect level at t_0 were allowed to vary across subjects in this model. Results (Table 3) showed that neither stressful events nor stress coping at t_0 significantly predicted a change in negative affect at the next report within 4 hours. Stressful event occurrence between t_0 and t_1 predicted an increase in negative affect at t_1, and stress coping between t_0 and t_1 was marginally associated with a decrease in negative affect at t_1. There was no independent effect of stress coping at t_0 on a change in negative affect, when controlling for later coping efforts (t_1). Although both stress coping and affect were assessed at the same report at t_1, the timeframe of the questions was different. Subjects were instructed to report whether they engaged in coping efforts since the last report, but

were asked to rate their levels of negative/positive affect just before the prompt sounded. Therefore, a change in affect reported at t_1 likely occurred later than coping efforts recorded at the same report. Reporting biases cannot be ruled out, however. Smoking at t_0 was also associated with decreased negative affect at t_1.

As in the previous lapse model, pre-quit coping experience did not significantly moderate the relation between stress coping (t_0) and later negative affect (t_1), contrary to my hypothesis derived from the strength model of self control. The number of stressful events (but not the number of stress coping efforts) during the two weeks prior to the quit date moderated the relation between contemporaneously reported stress coping and negative affect at t_1, however (Table 3). Those who reported more stressful events in the pre-quit period showed smaller reductions in negative affect (t_1) with post-quit stress coping (t_1) than those with fewer pre-quit stressful events. Significant gender effects were also found. Although there was no significant independent effect of stress coping at t_0 on a change in negative affect in men (p=.522), women showed significantly greater reduction in negative affect (t_1) following stress coping at t_0 (p<.03). In contrast, women showed significantly smaller reductions in negative affect (t_1) associated with stress coping effort at t_1 than did men.

Those with higher baseline negative affect as assessed by the PANAS and the NES had significantly higher post-quit negative affect intercepts, or average levels of negative affect in the absence of stress, coping, and smoking. Higher FTND scores were also associated with higher negative affect intercepts. There were no main effects of medication or counseling on post-quit negative affect, but the combination of active

bupropion SR and individual counseling significantly reduced the negative affect intercept.

Positive Affect within 4 Hours

I also tested the effect of stress coping on positive affect in the next 4 hours (t_1) (see Figure 1, path a_2). Positive affect (t_1) was regressed on the occurrence of stressful events and stress coping at the last report (t_0), controlling for previous (t_0) positive affect level so that I could interpret results in terms of a change in positive affect following new bouts of stress and coping. Stressful event occurrence and smoking were also assessed at t_0 and t_1 and included as covariates in the model. As in the negative affect model above, recent stress coping reported at t_1 was included in this model. Positive affect at t_0 was a significant, positive predictor of positive affect at t_1 (Table 4). Smoking was not significantly related to later positive affect (p=.200). Results indicated that stressful event occurrence at t_0 and t_1 were significantly associated with a decrease in positive affect at t_1. Stress coping at t_0, but not at t_1, significantly predicted an increase in positive affect at t_1, however. That is, there was no independent effect of stress coping at t_1 beyond the effect of earlier coping efforts.

As hypothesized, those who reported more stress coping efforts in the two weeks pre-quit showed a greater increase in positive affect following post-quit stress coping at t_0 than did those with fewer pre-quit stress coping episodes, controlling for the number of pre-quit stressful events reported. This was true for stress coping at t_1 as well. Those with more pre-quit stressful events reported lower positive affect following post-quit coping efforts (at t_0 only), when coping was controlled in the model. A significant gender effect

was detected as well. Women showed a significantly smaller increase in positive affect following stress coping at t_0 than did men.

Baseline covariates were related to the positive affect intercept. Average post-quit levels of positive affect (in the absence of stress, coping, and smoking were higher among those with higher baseline positive affect PANAS scores and those who were older.

Coping with Temptation within 4 Hours

I conducted analyses to assess the relation between stress coping (vs. no coping) and subsequent temptation coping efforts (see Figure 1, path a_3). The occurrence of coping in the face of temptations assessed at $t_1$was used as the dependent variable for this model. The instances in which no temptation was reported (10,227 reports) were not included and additional missing data and lack of variability across reports among some cases left 7,207 reports for this analysis. Stressful event occurrence at t_0 and t_1, temptation coping at t_0, and smoking at t_0 were included as covariates in the model in order to control for these variables when estimating stress coping–temptation coping relations (see Figure 1, path a_3). Temptation coping at t_0 was a significant, positive predictor of temptation coping at t_1 (Table 5). Smoking was not significantly related to temptation coping at the next report (p=.209). Only the model intercept was allowed to vary across subjects due to a failure to converge in more complex models. Stressful event occurrence at t_1 significantly reduced the likelihood of engaging in effortful temptation coping within the 4-hour period (t_1).Only a marginal association was found between stressful event reports at t_0 and later temptation coping (t_1). There was no significant effect of stress coping at t_0 on later temptation coping efforts; however, stress coping at t_1 was associated with increased likelihood of temptation coping at t_1. Men and women did

not appear to differ in stress-temptation coping or stress coping-temptation coping relations (all *p*s>.05, not shown).

Relations between stress coping and temptation coping did not vary as a function of pre-quit coping experience at either t_0 or t_1 (*p*s>.05, not shown). The significant differences in intercepts among men and women shown in Table 5 indicate that older subjects and women were more likely than younger subjects and men to report an effort to cope with temptations in the absence of stress, stress coping, initial smoking, or temptation coping at t_0.

Efficacy of Temptation Coping

I also examined the effect of stress coping (vs. no coping) on the efficacy of subsequent temptation coping (Figure 1, path m_6) in terms of preventing lapses between t_1 and t_2 (i.e., between 4 and 48 hours post-coping index report). The interaction term (stress coping at t_0 x temptation coping at t_1) was included as a predictor in this model. The occurrence of stressful events (t_0), stress coping (t_0), temptation coping (in the face of temptation only) (t_0) and (t_1), and smoking (t_0) and (t_1) were statistically controlled. The results showed that stress coping (vs. no coping) at the index report (t_0) did not moderate temptation coping effects at t_1 on subsequent (t_2) lapse risk. That is, reporting coping with a stressful event at t_0 did not interact with temptation coping at the next report within 4 hours (t_1) in predicting lapse risk over the 4-48 hours. Thus, the efficacy of temptation coping does not appear to be reduced by prior stress coping.

Mediation Models

I explored the extent to which changes in affective state (negative and positive affect) (t_1) as well as occurrences of temptation-coping (t_1) mediated the relation between

stress coping (t_0) and smoking lapse over the next 48 hours. This analysis was conducted despite the lack of a significant relation between stress coping at t_0 and smoking lapse occurrence between t_0 and t_2 in order to determine whether the candidate mediators were related to lapse probability as predicted (i.e., to test the *b* paths even in the absence of the *c* path). The occurrence of stressful events at t_0 andt_1, stress coping at t_0 and t_1, and smoking (t_0) were included as covariates in these models (Table 2, middle and bottom panels). None of the candidate mediators was found to be significantly predictive of later lapse likelihood between t_1 and t_2. That is, negative affect, positive affect, and temptation coping were not significantly predictive of lapsing in the next two days, after controlling for initial smoking and the occurrence of stressful events and coping efforts. As such, the mediation model proposed in Figure 2 was not supported and estimation and significance testing of the mediated effects (Figure 1, paths a_1b_1, a_2b_2, and a_3b_3) was not conducted.

Exploratory Analyses

Finally, I explored the differential effects of specific coping strategies (i.e., cognitive, behavioral, and acceptance-based coping) on smoking status and putative mediators (Table 6). None of the three coping strategies assessed at t_0 was significantly related to lapse likelihood within 48 hours. Similarly, none of the specific coping strategies reported at t_0 was associated with reduced negative affect at the next report within 4 hours. Acceptance coping at the next report (t_1), however, was associated with lower negative affect levels reported in the same report, whereas cognitive and behavioral coping were not. The number of pre-quit stressful events and behavioral stress coping efforts significantly moderated the effect of behavioral coping (t_1) on negative affect. Higher pre-quit stress occurrence frequencies were associated with greater negative affect

reported at t_1 following recent use of behavioral coping reported at both t_0 and t_1. Those with more pre-quit behavioral stress coping experience, in contrast, reported significantly lower levels of negative affect following t_0 and t_1 behavioral coping than those with less pre-quit behavioral coping experience. The opposite was true for acceptance based coping, however. Those who had more acceptance coping experience during the pre-quit period showed significantly higher levels of negative affect at t_1 following t_0 acceptance coping than those with fewer pre-quit acceptance coping efforts.

For positive affect, behavioral coping at t_0 predicted a decrease while the other strategies (i.e., cognitive and acceptance coping) predicted an increase in positive affect following coping efforts. Cognitive and behavioral coping at t_0, and acceptance-based coping at t_1, had a significantly weaker effect on positive affect at t_1 among women than among men. Men showed significantly greater increase in positive affect (t_1) following cognitive coping at t_0 (p=.035) whereas men showed significantly greater reductions in positive affect (t_1) associated with behavioral coping effort at t_0 and acceptance coping effort at t_1 than did women (ps<.05). The differential effects of coping strategies thus appear to be moderated by gender. Later coping (at t_1) was not significantly related to positive affect ratings at t_1 overall. The number of pre-quit stress coping experience using any of the three strategies did not moderate the relations between their post-quit counterparts and positive affect.

With regard to temptation coping at t_1, results indicated that only cognitive and acceptance coping at t_1 (not at t_0) were significantly related to the probability of reporting temptation coping. Behavioral coping was not significantly related to temptation coping at t_0 or t_1. No gender differences were observed in coping strategy relations with

temptation coping. Those with greater pre-quit stress coping experience, however, showed increases in the likelihood of reporting temptation coping following cognitive coping at t_0, relative to those with fewer pre-quit coping reports.

Discussion

The purpose of this study was to use EMA data to test hypotheses regarding the effects of coping with stressful events on affect, behavior, and the likelihood of lapse after an attempt to quit smoking. A secondary aim was to determine whether individual differences in prior coping experience moderated such relations. Results provided mixed support for the model. No direct effect of stress coping on subsequent lapse risk was detected, and the candidate mediators (negative affect, positive affect, and temptation coping) were not significantly predictive of later lapse risk. As such, the portion of the model predicting lapse risk was not well supported. Other elements of the model received greater support, however. Negative affect, positive affect, and temptation coping were all related to reports of stressful events and stress coping in at least some groups of subjects. These relations were moderated by gender and by the frequency of stress occurrence and stress coping pre-quit in complex ways. As such, the *a* paths in the model received greater support than either the *b* or *c* paths.

Hypothesis 1: c path. The results from the first model indicated that neither stressful event occurrence nor stress coping at the index report was significantly associated with a change in lapse risk 48 hours later, whereas occurrence of stress and stress coping over the 48 hours were independently predictive of increased lapse risk in the same 48-hour period. These findings were inconsistent with the generally held view that coping with stress protects against smoking lapses, at least in a 48 hour interval. Rather, the current results showing that additional coping within 48 hours of the index report predicted lapsing during the same period suggest that stress coping efforts may have a detrimental effect on smoking cessation efforts. The possibility that more coping

is reported following a lapse cannot be ruled out based on the analyses presented here, however. It may be that those who lapsed reported more stressful events or coping efforts after lapsing in this study, but stress and coping would not predict lapsing prospectively. It is also possible that the 48-hour interval between index coping events and lapsing was too great and that an effect would be detected in a shorter interval.

In addition, given the lack of qualitative information about stressful events (e.g., level of distress, unpredictability, or chronicity) in this study, the possibility that more coping efforts are associated with more stressful, unpredictable, or chronic events cannot be dismissed. It is possible that increased lapse risk in the current study was not a direct result of coping efforts, but rather an indirect effect of highly stressful events that prompted coping efforts and independently increased lapse risk.

Moreover, contrary to my hypothesis, the results did not show moderating effects of pre-quit coping experience on relations between post-quit stress coping and later lapse. Based on the strength model of self control, I predicted that those who reported more frequent coping with stress pre-quit would show reduced lapse risk following coping post-quit than would those with less pre-quit coping practice. This hypothesis was not supported. This may be because the assessment of coping experience may have been inadequate. The measure used (number of coping efforts reported in EMA reports during the two weeks prior to quitting) is novel and may not adequately capture the ability to engage in effective coping in a relatively effortless manner that will not deplete self-control resources. Cole and Maxwell (2003) have discussed the importance of choosing optimal intervals to detect mediated effects. More research on the ordering and duration of coping-lapse relation is needed. Despite the null result for the test of path c, lapse

models did reveal some findings that are consistent with past research. Smoking at the index report was associated with a 1.23-1.49 factor increase in the odds of smoking within the next 48 hours. This is consistent with past research showing that any smoking post-quit is a strong predictor of subsequent smoking (Westman et al., 1997). In addition, active bupropion SR significantly reduced the risk of lapsing relative to placebo, consistent with meta-analyses of bupropion SR efficacy for smoking cessation (Fiore et al., 2008).

Hypothesis 2: a paths. The results from the affect models indicated that stressful event occurrence and stress coping at the index report (t_0) were significantly associated with a change in positive affect, but not in negative affect, within 4 hours (t_1). Change in negative affect between t_0 and t_1 was predicted by stressful events and coping reported contemporaneously (at t_1). Analyses revealed that stress coping generally improved affect within 4 or fewer hours, although positive affect appeared to be more sensitive to a single, index bout of coping than did negative affect. Moreover, some of the relations between stress coping and affect were moderated by gender and pre-quit coping experience as discussed below.

Negative affect. The results from the negative affect model did not support the relation between stress coping and negative affect reported contemporaneously or up to 4 hours later. Furthermore, stressful events did not predict a change in negative affect within 4 hours. The model also indicated that neither pre-quit stressors nor coping experience moderated the relation between post-quit stress coping and later negative affect. I hypothesized that stress coping would help decrease negative affect within the next 4 hours, especially those who practiced more stress coping during the pre-quit period

which helped them to cope more efficiently and effectively and in turn, successfully reduce negative affect. This hypothesis was not supported. This null result may be a result of the inadequate assessment of negative affect using EMA. It should be noted that there was low variability in negative affect, compared to positive affect, and over 40 % of the answers were 1 or 2 on an 11-point scale ranging from 1 (No!!) to 11 (Yes!!). Another possible reason for the null results is that, as previously discussed, the type and severity of stressful events were not taken into the account in this model. A study by Stone et al. (1995) suggested that the undesirability of a problem was positively related to subsequent negative affect, regardless of the coping efforts reported. For instance, compared with the effects of less stressful events, more undesirable or stressful problems were more likely to evoke both coping efforts and higher levels of negative mood. However, unlike Stone et al (1995), the current model used the presence vs. absence of stress coping efforts, rather than the frequency of coping efforts, as a predictor of negative affect. Stress coping was coded dichotomously for the present analyses because the effects of coping effort, in comparison to no coping, on candidate mediators and lapse risk were of interest. Thus, it is unclear whether the lack of negative affect change following stress coping effort was influenced by the severity or frequency of the events or related coping efforts.

There were several findings worth noting in this model, however. The number of pre-quit stressful events, but not stress coping, moderated the relation between coping (t_1) and negative affect (t_1) reported in the same post-quit report. Those who experienced more stress in the pre-quit period were significantly less likely to improve their mood (i.e., reduce negative affect) after recent coping with post-quit stress (reported in the same

report). Significant gender effects were also observed. Following a coping effort (t_0), women showed a significantly greater decrease in negative affect than did men. On the contrary, more recent coping (t_1) helped reduce negative affect in men, whereas women did not show a significant reduction of negative affect associated with contemporaneous reports of coping. In addition, smoking at t_0 predicted a decrease in negative affect at t_1. This result adds support to the negative reinforcement model of addiction (e.g., Baker et al., 2004) in that smoking alleviates negative affective states.

Positive affect. The analysis for positive affect indicated that stress coping at the index report significantly predicted an increase in positive affect within the next 4 hours, as hypothesized. Moreover, those who had more frequent stress coping efforts during the pre-quit period (2 weeks) showed a greater increase in positive affect following a post-quit stress coping effort at both t_0 and t_1, compared to those with less pre-quit coping practice. That is, the number of pre-quit stress coping efforts moderated post-quit stress coping-positive affect relations in the model (Table 3). This may be due to practice effects on coping efficacy as an affect regulation strategy. In other words, coping effects on affect (i.e., increasing positive affect) may have been enhanced by prior coping practice. It is also notable that a gender effect was observed at t_0. The significant increase in positive affect associated with earlier stress coping found in men was significantly smaller in women. The results from this model revealed that coping with stressful events may increase positive affect (over the next 4 hours), especially in those who practiced coping prior to their quitting attempts and in men.

Results of the affect models suggest that positive affect may be more sensitive to a single episode of stress or coping than is negative affect, whereas negative affect ratings

are more strongly related to contemporaneous coping reports than are positive affect ratings. The results should be interpreted with caution since this study used somewhat arbitrary assessment timeframes which may have contributed to the findings. For example, Pennebaker and Beall (1986) showed that a certain coping strategy resulted in an immediate increase in negative affect, but its long-term effects (e.g., over 6 months) on health was favorable. Moreover, the significance of the differences across models is not known, and may reflect differences in variance in the positive and negative affect ratings rather than substantive differences in the timeframe of coping-affect relations.

Temptation coping. Next, I tested whether the likelihood of engaging in effortful temptation coping differs following coping with a stressful event. Contrary to my hypothesis, there was no relation between stress coping and the occurrence of later temptation coping. Instead, reports of stress coping (t_1) were positively associated with contemporaneous reports of temptation coping (t_1). That is, the more one reported coping with stressors, the more likely one was to report coping with temptation in the same period of time. This concurrent but not prospective association may reflect an unclear differentiation between temptation coping and stress coping among subjects. It is also possible that reported coping efforts may have reflected a state of motivation which influenced one's coping efforts to deal with both stressors and temptations to smoke. Furthermore, recent stressful events (t_1) reduced the occurrence of contemporaneous temptation coping efforts. This may indicate that the decision or ability to exert coping efforts can be diminished by earlier undesirable states of affect (e.g., low positive affect/ high negative affect), which may or may not elicit conscious coping efforts. Individual

differences in pre-quit stress coping efforts did not moderate relations between post-quit stress coping and temptation coping in this model, contrary to my hypothesis.

The analysis of the effects of stress coping (vs. no coping) on the efficacy of subsequent temptation coping also suggested that the efficacy of temptation coping was independent of the occurrence of previous stress coping efforts. In other words, temptation coping was equally ineffective at reducing later lapse risk whether or not stress coping was recorded at the previous report. There were no individual differences that moderated the above relation.

Hypothesis 3: b paths. A series of analyses revealed that none of the putative mediators of stress coping effects on smoking lapse was significantly predictive of lapse. Negative affect, positive affect, and temptation coping within 4 hours of an index stress report did not predict smoking lapse within the next 44-48 hours. The lack of significant relations between affect or temptation coping and later lapse risk may be a result of the suboptimal timeframes of assessments. Shiffman (2005) found that rapid increases in negative affect in the preceding few hours predicted lapse. This may suggest that the interval of path *b*s (over 48 hours) may have been too long to detect any effects of the putative mediators.

Exploratory analyses. Finally, exploratory analyses revealed differential effects of specific coping strategies on changes in negative and positive affect and the occurrence of temptation coping (t_1). In the negative affect model, acceptance coping (t_1), but not cognitive or behavioral coping (t_1), was significantly associated with a reduction in negative affect (t_1). In other words, recent acceptance-based coping may have been effective at immediately reducing negative affect whereas cognitive and behavioral

coping were not. However, it is worth noting that the results do not necessarily signify that a specific coping strategy is superior at improving later affect because we only examine affect changes within 30 minutes and 4 hours after coping; shorter and longer intervals may reveal different relations between coping and affect. Furthermore, more frequent pre-quit acceptance coping was associated with higher levels of negative affect following post-quit acceptance coping, whereas pre-quit behavioral coping predicted lower negative affect after post-quit behavioral coping efforts (t_0 and t_1). A lack of clarity in defining acceptance based coping may have contributed to these results. Perhaps, frequent acceptance coping during pre-quit period may represent pre-existing resignation or demoralization, rather than repeated practice of more adaptive acceptance coping strategies. There was no moderating effect of pre-quit coping experience on the significant relation between positive affect and contemporaneous acceptance-based coping reports.

On the other hand, behavioral coping at the index report predicted a reduction in positive affect while cognitive and acceptance coping predicted an increase in positive affect within the next 4 hours. Although behavioral coping reported in this study may encompass a number of varying strategies, this result resembles previous findings by Stone et al. (1995) that direct action (e.g., trying something to solve the problem) was inversely associated with positive affect. Stone et al. (1995) posited that exerting coping efforts which allocate attention to the problem at hand, such as taking actions to resolve issues, predicted poorer short-term mood, compared to situations where no such actions were taken. However, Stone el al. (1994) also found that the use of several coping strategies, such as catharsis, seeking social support, direct problem-solving action, and

relaxation (i.e., behavioral based coping), increased in the face of a higher level of problem undesirability, whereas the use of situation redefinition (i.e., cognitive-based coping) decreased[4]. As such it is also possible that the stressful events that evoked behavioral coping were more stressful than those that did not, and may thus have had greater impact on positive affect.

Women showed significantly weaker relations between changes in positive affect and all three coping strategies reported in the index report, than did men. For cognitive coping, women showed less of an increase in positive affect. In contrast, women exhibited less of a reduction in positive affect following behavioral coping at t_0 and acceptance coping at t_1, compared to men. Previous studies (e.g., Porter et al., 2000) that investigated gender differences in coping strategies using momentary assessments found that there were gender differences in retrospective surveys while there were no gender differences in momentary coping reports. That is, recall bias about coping strategies differed between men and women; however, there were no actual gender differences in coping behaviors. However, to my knowledge, no study to date has investigated the moderating roles of gender in the relations between coping and subsequent mood and behavior.

Differential effects of specific coping strategies on the occurrence of temptation coping were also tested. As found in the positive affect model, recent cognitive and acceptance, but not behavioral coping, were significant predictors of the occurrence of temptation coping. That is, those who reported using cognitive or acceptance strategies to cope with stress, were more likely to report coping with temptation episodes in the next

[4] It should be noted that all participants in this study were male.

few hours than were those who did not use these strategies. Those who used behavioral coping (which may be more exhausting than cognitive or acceptance coping) to deal with a stressful event , in contrast, were less likely to report coping with a temptation event than were those who did not use behavioral coping earlier.

Limitations

The interpretation of the results from this study should be tempered by recognizing the following study limitations. First, the psychometric quality of the measures used may be limited, given that the EMA consisted of a few items selected from validated measures of affect (mainly to control the length of the report) and the reliability and validity of such brief assessments have not been well documented. Furthermore, the coping efforts and styles as well as stressful events were not explicitly defined for subjects. Therefore, the data reflect participants' interpretation of coping efforts, events, and each coping strategy assessed (behavior, cognitive or acceptance). A second limitation in this study relates to possible reporting biases. Although reports are randomly prompted to minimize such biases, missing reports may be associated with certain situations or states (e.g., severe stress or demanding coping). Another limitation of this study is its non-experimental nature. As variables of interest (e.g., stress occurrence, coping effort, and affect) were not manipulated, the relations (causal and mediational) should be interpreted with caution. At the same time, potential differences such as participants' chronic coping style prior to the study (coping history prior to the pre-quit period) which may influence coping efficacy and outcomes were not assessed beyond a simple count of self reported coping efforts in the 2 weeks immediately preceding the quit attempt. Moreover, the generalizability of the findings may be limited particularly since only smokers highly motivated to quit and willing to participate in a treatment study which required considerable effort were enrolled. The sample was also homogeneous in terms of racial ethnicity and free of current depression or a history of severe mental illness. Although few differences between the sample retained for analyses and those who

were excluded were detected, the sample analyzed may differ from the general population. Finally, the best timeframe (seconds, minutes, days, etc.) in which to study the effect of coping on subsequent affect and coping effort is uncertain. As such, the time-frame used in this study may not be an optimal way to investigate the role of coping in smoking cessation effort.

Conclusions

This study assessed relations among coping, affect and behavior using EMA data obtained from daily smokers engaged in an effort to quit smoking. The hypotheses about the direct effects of coping and both mediators and moderators of coping effects on subsequent affect, coping effort and efficacy, and smoking outcomes were tested using multilevel models. The a paths in the model, connecting stressful events and stress coping to negative affect, positive affect, and temptation coping, received greater support compared to the b and c paths, predicting lapse risk. Results from this study supported the generally held notion that stress coping has beneficial effects on later affect. Results also suggested that pre-quit coping efforts and gender moderated relations between post-quit coping and later affect relations. Assessing qualitative information about stressful events (e.g., chronicity, stress level, predictability) and coping efforts (e.g., expectation, duration, intensity) in future studies may contribute to a better understanding of effects of stress coping on later lapse risks. It is also valuable to study negative and positive affect independently in order to further assess the differential effects of coping efforts on affect as well as their potential moderators. Moreover, using different/multiple timeframes to assess the effects of coping and affect on lapse risks in future research may help elucidate underlying mechanisms.

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Figure Captions

Figure 1. Participation flow diagram depicting the number of subjects excluded from analyses due to drop out prior to the quit day, the absence of any reports of stressful events, and the absence of any reports of stress coping efforts.

Figure 2. Model of hypothesized relations among stress coping, putative mediators 4 hours later, and lapse likelihood 48 hours post-stress coping. Stress coping (0=no coping, 1=coping) is shown as a predictor of increased positive affect, decreased negative affect, and decreased likelihood of temptation coping (0=no coping, 1=coping) at the next report within 4 hours. Paths labeled *a* represent stress coping effects on putative mediators (e.g., a_1 is the coping effect on negative affect) of coping effects on smoking lapse likelihood. Paths labeled *b* represent the relation between the putative mediators and lapse risk within 48 hours. Positive affect and temptation coping were predicted to decrease lapse likelihood, whereas negative affect was predicted to increase lapse risk. Direct (*c'*) and indirect (*a* and *b*) paths link stress coping to lapse risk (the probability of lapse) within 48 hours of the index stress coping effort. Pre-quit coping experience was included as a moderator of relations between coping, the putative mediators, and lapse risk (i.e., paths m_1, m_2, m_3, m_4,and m_5), indicated by the gray arrows to indicate that greater pre-quit coping experience was thought to enhance the efficacy of stress coping post-quit, such that coping would lead to greater increases in positive affect, decreases in negative affect, and decreased lapse risk among those who report more frequent stress coping prior to quitting, relative to those who cope less with stress pre-quit.

Table1. Demographic characteristics of final sample (N=372).

Variable	***Value***	***n (%)***
Sex (N=372)	Female	198 (53.2%)
Race/Ethnicity	Hispanic	4 (1.1%)
(N=369)	White	332 (89.2%)
	African-American	22 (5.9%)
	Asian, Pacific Islander	3 (0.8%)
	American Indian	1 (0.3%)
	Other	11 (3.0%)
Marital Status	Married	162 (43.5%)
(N=370)	Divorced	69 (18.5%)
	Never married	91 (24.5%)
	Cohabitating	34 (9.1%)
	Separated	8 (2.2%)
	Widowed	6 (1.6%)
Education	< High school graduate	13 (3.5%)
(N=370)	High school graduate	77 (20.7%)
	Some college	184 (49.5%)
	College degree	96 (25.8%)
Employment Status	Employed for wages	273 (73.4%)
(N=367)	Self-employed	36 (9.7%)
	Unemployed <1 year	18 (4.8%)
	Homemaker	17 (4.6%)
	Student	8 (2.2%)
	Retired	9 (2.4%)
	Disabled	6 (1.6%)
Household Income	< $25,000	105 (28.9%)
(N=363)	$25,00-$34,999	57 (15.3%)
	$35,000-$49,999	71 (19.1%)
	$50,000-$74.999	76 (20.4%)
	>$75.000	55 (14.5%)
		M (SD)
Age (N=372)		38.94 (11.94)
Age at first cigarette (N=372)		13.53 (3.92)
Cigarettes smoked per day (N=372)		21.44 (10.26)
Previous quit attempts (N=347)		6.19 (11.45)
Baseline CO level (N=371)		24.54 (11.74)
Baseline FTND Score (N=370)		4.98 (2.33)

Figure 1. Participation flow diagram.

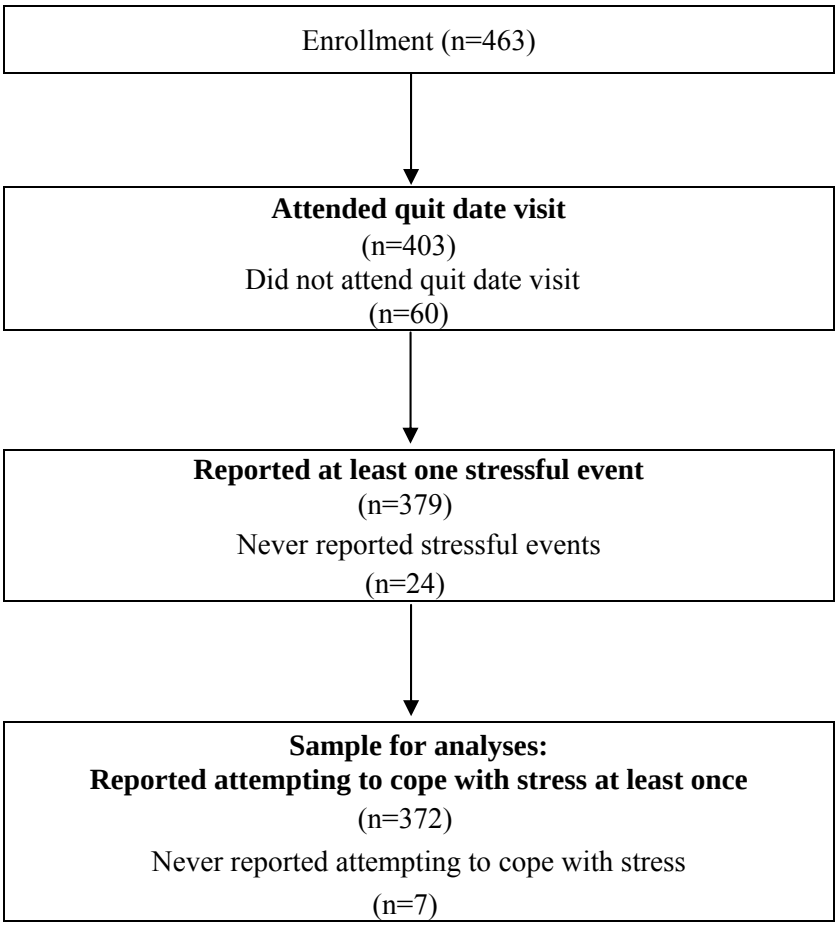

Figure 2. Model of hypothesized relations among coping, affect, and smoking lapse.

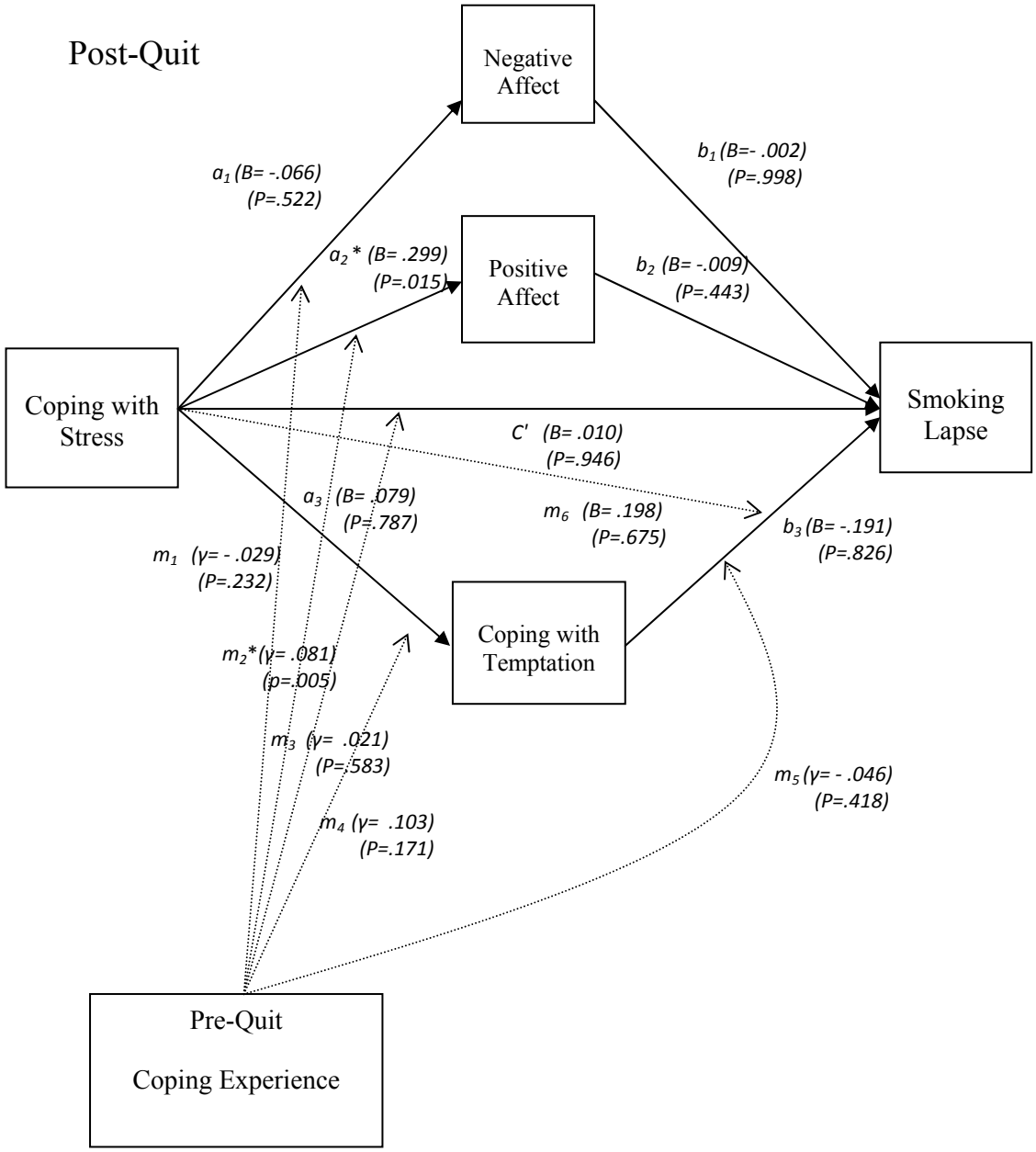

Table 2. Stress, stress coping, and candidate mediator effects on lapse risk over 48 hours.

Predictor	*Coefficient*	*Standard Error*	*T-ratio*	*P-value*	*Odds Ratio*	*95% CI*	*df*
Direct effect *c* path							
Intercept [a]	- 0.823	0.251	- 3.272	0.002*	0.439	(0.268,0.720)	344
Active bupropion SR	- 0.989	0.358	- 2.766	0.006*	0.371	(0.184,0.751)	33,647
Age	0.028	0.015	1.881	0.060	1.029	(0.999,1.060)	33,647
t_0 Stressful Event	- 0.092	0.114	- 0.802	0.422	0.912	(0.729,1.141)	33,647
t_0 Stress Coping	0.010	0.140	0.068	0.946	1.010	(0.768,1.328)	33,647
t_0 Smoking	0.302	0.049	6.173	0.000*	1.352	(1.228,1.488)	33,647
t_2 Stressful Event	0.199	0.068	2.914	0.004*	1.221	(1.067,1.396)	33,647
t_2 Stress Coping	0.222	0.091	2.438	0.015*	1.249	(1.045,1.493)	33,647
Gender	- 0.126	0.069	-1.837	0.066	0.881	(0.770,1.009)	33,647
Mediation *b* paths [b]							
t_0 Negative Affect	0.005	0.014	0.356	0.722	1.005	(0.978, 1.033)	21,274
t_1 Negative Affect	- 0.002	0.014	-1.116	0.908	0.998	(0.971, 1.026)	21,274
t_0 Positive Affect	- 0.010	0.012	- 0.814	0.416	0.990	(0.968, 1.014)	21,274
t_1 Positive Affect	- 0.009	0.012	- 0.767	0.443	0.991	(0.969, 1.014)	21,274
t_0 Temptation Coping	0.169	0.114	1.278	0.139	1.814	(0.946, 1.482)	7,137
t_1 Temptation Coping	- 0.191	0.141	-1.352	0.177	0.826	(0.626, 1.090)	7,137
t_0 Stress Coping x t_1 Temptation Coping **	0.198	0.474	0.419	0.675	1.219	(0.482, 3.085)	7,137

[a] Random coefficient, df = 344, reliability = .862. All other predictors were treated as fixed to facilitate model convergence.
[b] Analyses run with the following covariates: stress events t_0& t_1, stress coping t_0& t_1, and smoking t_0. Intercept df = 343/343/313, reliability = .829 /.829/.736, respectively.

**The moderating effect of stress coping (t_0) on the efficacy of temptation coping (t_1) was also tested using t_0 stress coping x $t_1$temptation coping interaction as a predictor and lapse risk between 4- 48 hours as a dependent variable. Time-varying covariate were stress events t_0, stress coping t_0, temptation coping t_0& t_1 and smoking t_0 & t_1 were included in the model. As in the mediation model, stress coping (t_0) did not interact with temptation coping (t_1) in predicting lapse risk between t_1 and t_2.

t_0 = Index report
t_1 = Next report within 4 hours of index report
t_2 = 48 hours after index report

Table 3. Negative affect within 4 hours.

Fixed Effect	*Coefficient*	*Standard Error*	*T-ratio*	*P-value*
Intercept [a]	3.150	0.147	21.428	0.000*
Active bupropion SR & Counseling	- 0.838	0.298	- 2.810	0.006*
FTND	0.078	0.032	2.455	0.015*
Negative PANAS	0.036	0.014	2.630	0.009*
NES	0.119	0.024	4.963	0.000*
t_0 Stressful Event	0.063	0.074	0.850	0.395
t_0 Negative Affect [b]	0.315	0.014	22.898	0.000*
t_0 Stress-Coping	- 0.066	0.103	- 0.640	0.522
Gender	- 0.169	0.077	- 2.182	0.029*
t_0 Smoking	- 0.128	0.035	- 3.660	0.000*
t_1 Smoking (in 4 hours)	0.030	0.035	0.864	0.388
t_1 Stressful Event (in 4 hours)	1.139	0.073	15.511	0.000*
t_1 Stress-Coping (in 4 hours)	- 0.192	0.102	- 1.871	0.061
Gender	0.186	0.076	2.450	0.015*
Pre-quit Stressful Events	0.054	0.023	2.343	0.019*
Pre-quit Stress-Coping Efforts	- 0.042	0.024	- 1.743	0.081

[a] Random coefficient, df = 340. [b] Random coefficient, df = 346. All other predictors were treated as fixed, with df = 21,524, to facilitate model convergence.
Reliability Intercept = .979, Negative Affect t_0 = .602, N = 342.

Table 4. Positive affect within 4 hours.

Fixed Effect	*Coefficient*	*Standard Error*	*T-ratio*	*P-value*
Intercept [a]	7.303	0.105	69.606	0.000*
Age	0.045	0.009	5.151	0.000*
Positive PANAS	0.098	0.015	6.486	0.000*
t_0 Stressful Event	- 0.177	0.090	- 1.973	0.048*
t_0 Positive Affect [b]	0.301	0.015	19.834	0.000*
t_0 Stress-Coping	0.299	0.123	2.432	0.015*
Gender	- 0.248	0.090	- 2.747	0.006*
Pre-quit Stressful Events	- 0.080	0.027	- 3.003	0.003*
Pre-quit Stress-Coping Efforts	0.081	0.028	2.874	0.005*
t_0 Smoking	- 0.055	0.043	- 1.283	0.200
t_1 Smoking (in 4 hours)	0.040	0.043	0.942	0.347
t_1 Stressful Event (in 4 hours)	- 0.490	0.090	- 5.452	0.000*
t_1 Stress-Coping (in 4 hours)	0.021	0.109	0.193	0.847
Pre-quit Stressful Events	- 0.039	0.029	- 1.381	0.167
Pre-quit Stress-Coping Efforts	0.070	0.030	2.353	0.019*

[a] Random coefficient, df = 344. [b] Random coefficient, df = 346. All other predictors were treated as fixed, with df = 21,529, to facilitate model convergence.
Reliability: Intercept = .984, Positive Affect t_0 = .608, N = 340.

Table 5. Coping with temptation within 4 hours.

Fixed Effect	*Coefficient*	*Standard Error*	*T-ratio*	*P-value*	*Odds Ratio*	*95% CI*
Intercept [a]	0.247	0.153	1.617	0.107	1.280	(0.948,1.728)
Age	0.026	0.008	3.363	0.001*	1.027	(1.011,1.042)
Gender	0.474	0.183	2.583	0.011*	1.606	(1.120,2.302)
t_0 Temptation-Coping	1.651	0.103	15.959	0.000*	5.215	(4.258,6.388)
t_0 Stressful Event	- 0.418	0.223	-1.872	0.061	0.658	(0.425,1.020)
t_0 Stress-Coping	0.079	0.292	0.270	0.787	1.082	(0.610,1.918)
t_0 Smoking	- 0.203	0.161	-0.258	0.209	0.816	(0.595,1.120)
t_1 Stressful Event (in 4 hours)	- 0.076	0.220	- 4.882	0.000*	0.341	(0.221,0.525)
t_1 Stress-Coping (in 4 hours)	1.676	0.310	5.410	0.000*	5.349	(2.914,9.821)

[a] Random coefficient, df = 317. All other predictors were treated as fixed, with df = 7,194, to facilitate model convergence.
Reliability: Intercept = .581, N = 320.

Table 6. Cognitive, behavioral, and acceptance based coping strategies.

Outcome Variable	*Predictor*	*Coefficient*	*Standard Error*	*T-ratio*	*P-value*	*Odds Ratio*	*95% CI*	*df*
Lapse risk over 48 hours [a]								
	t_0 Stress Coping-Cognitive	0.028	0.143	0.193	0.848	1.028	(0.777,1.360)	33647
	t_0 Stress Coping-Behavioral	- 0.055	0.151	- 0.363	0.717	0.947	(0.705,1.272)	33647
	t_0 Stress Coping-Acceptance	- 0.066	0.141	- 0.464	0.642	0.937	(0.710,1.235)	33647
	t_2 Stress Coping **	0.014	0.080	1.756	0.079	1.150	(0.984,1.345)	33647
Negative Affect within 4 hours [b]								
	t_0 Stress Coping-Cognitive	- 0.075	0.090	- 0.834	0.405			21514
	t_0 Stress Coping-Behavioral	- 0.033	0.093	- 0.357	0.721			21514
	Pre-quit Stressful Event	0.033	0.013	2.1627	0.009*			21514
	Pre-quit Behavioral-Coping	- 0.039	0.017	- 2.220	0.026*			21514
	t_0 Stress Coping-Acceptance	0.053	0.089	0.598	0.550			21514
	Pre-quit Stressful Event	- 0.028	0.015	- 1.823	0.068			21514
	Pre-quit Acceptance-Coping	0.045	0.020	2.199	0.028*			21514
	t_1 Stress Coping-Cognitive	0.050	0.089	0.557	0.577			21514
	Pre-quit Stressful Event	0.024	0.014	1.674	0.094			21514
	t_1 Stress Coping-Behavioral	0.032	0.093	0.347	0.728			21514
	Pre-quit Stressful Event	0.041	0.012	3.324	0.001*			21514
	Pre-quit Behavioral-Coping	- 0.073	0.017	- 4.296	0.000*			21514
	t_1 Stress Coping-Acceptance	- 0.280	0.088	- 3.166	0.002*			21514
	Pre-quit Stressful Event	- 0.005	0.014	- 0.372	0.709			21514
	Pre-quit Acceptance-Coping	0.028	0.019	1.515	0.130			21514
Positive Affect within 4 hours [c]								
	t_0 Stress Coping-Cognitive	0.511	0.155	3.294	0.001*			21512
	Gender	- 0.327	0.155	- 2.104	0.035*			21512
	t_0 Stress Coping-Behavioral	- 0.509	0.161	- 3.166	0.002*			21512
	Gender	0.379	0.159	2.381	0.017*			21512
	t_0 Stress Coping-Acceptance	0.294	0.146	2.013	0.044*			21512
	Gender	- 0.252	0.147	-1.719	0.085			21512
	t_1 Stress Coping-Cognitive	0.091	0.157	0.577	0.563			21512
	t_1 Stress Coping-Behavioral	0.116	0.168	0.686	0.492			21512
	Pre-quit Stressful Event	0.028	0.015	1.827	0.067			21512
	t_1 Stress Coping-Acceptance	- 0.136	0.148	- 0.919	0.359			21512
	Gender	0.293	0.149	1.970	0.048*			21512

Table 6 cont'd.

Outcome Variable	*Predictor*	*Coefficient*	*Standard Error*	*T-ratio*	*P-value*	*Odds Ratio*	*95% CI*	*df*
Temptation Coping within 4 hours [d]								
	t_0 Stress Coping-Cognitive	- 0.226	0.322	-0.703	0.482	0.798	(0.425,1.499)	7182
	Pre-quit Stressful Event	- 0.241	0.131	- 1.844	0.065	0.786	(0.608,1.015)	7182
	Pre-quit Acceptance-Coping	0.310	0.148	2.092	0.036*	1.363	(1.020,1.822)	7182
	t_0 Stress Coping-Behavioral	0.258	0.338	0.763	0.445	1.294	(0.667,2.511)	7182
	t_0 Stress Coping-Acceptance	0.163	0.323	0.504	0.614	1.177	(0.625,2.218)	7182
	t_1 Stress Coping-Cognitive	1.404	0.367	3.831	0.000	4.073	(1.986,8.356)	7182
	t_1 Stress Coping-Behavioral	0.239	0.374	0.639	0.523	1.270	(0.610,2.641)	7182
	t_1 Stress Coping-Acceptance	0.750	0.373	2.011	0.044	2.119	(1.019,4.405)	7182

Reliability: Intercept = .862 [a], .979 [b], 984 [c], 585 [d] N = 347 [a], 342 [b], 340 [c], 320 [d]. Negative Affect t_0 = .603.
Positive Affect t_0 = .609.
All the same covariates as the models that collapse across coping type were included.

**Stress coping (collapsed across coping type) at t_2 was used because dividing into three types of coping resulted in a failure to converge.

t_0 = Index report
t_1 = Next report within 4 hours of index report
t_2 = 48 hours after index report