METACOGNITION AND CRAVINGS DURING SMOKING CESSATION

by

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M.A., The University of British Columbia, 2006

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

in

THE FACULTY OF GRADUATE STUDIES

(Psychology)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

June 2012

Abstract

Nicotine cravings are important predictors of smoking cessation difficulty and relapse. Metacognitive models suggest that the ways people think about and respond to cravings may affect how severe cravings become. Specifically, appraising cravings to mean something awful about oneself or one's quit attempt (i.e., as meaning one is weak-willed, destined to fail, or out of control) is predicted to increase distress. Negative affect is then theorized to trigger further craving and motivate unhelpful coping responses such as thought suppression and rumination.

The present study examined evidence for this metacognitive model using an experimental paradigm. One hundred and seventy-six adult smokers participated in two lab sessions either during or preceding a cessation attempt; during the first session, participants received metacognitive, control or no psychoeducation. Dependent variables were assessed using ecological momentary assessment and questionnaires four days later.

Metacognitive models predict that overly negative beliefs increase cravings and withdrawal-related distress. Consistent with this hypothesis, metacognitive beliefs correlated with increased distress and withdrawal symptoms among both continuing smokers and active quitters. Providing psychoeducation challenging maladaptive beliefs about cravings did not causally impact craving or smoking four days later, but psychoeducation was associated with differential diurnal variation in cravings. Specifically, abstinent smokers experienced lower cravings early and later in the day if they received metacognitive psychoeducation.

An alternative directional hypothesis suggests that withdrawal symptoms increase beliefs. Consistent with this, changes in negative affect predicted changes in metacognitive beliefs. Quitting smoking did not causally impact beliefs, but successfully abstinent smokers showed a greater decline in overly negative craving interpretations. Regarding metacognitive responses, cessation increased use of reappraisal, distraction and

suppression, but there were no differences in strategies used by successful and unsuccessful abstainers. Only rumination predicted smoking one month later.

Overall, results provide partial support for metacognitive models. Causal effects of beliefs on withdrawal symptoms (and vice versa) were not detected but nonexperimental results imply a bidirectional relationship. Future research on rumination and certain types of metacognitive beliefs is warranted. Examination of clinical applications of metacognitive models would also be valuable, particularly among depressed smokers or as an adjunct to behavioural approaches to smoking cessation.

Preface

This work was conducted in UBC's Fear and Anxiety Laboratory under the supervision of Dr. Sheila Woody. I was responsible for study design and data collection. I also conducted all of the testing and wrote all of the material contained herein. This research was approved by the University of British Columbia Office of Research Services Behavioural Research Ethics Board, UBC BREB #H08-01255.

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Acknowledgements

I offer my enduring gratitude to the faculty, staff and my fellow students at UBC, who have continually facilitated and engaged my desire to work in this field. I owe particular thanks to Dr. Sheila R. Woody for her never-ending support and guidance, I feel extremely fortunate to have such an outstanding mentor and role model.

Thanks to my proposal committee members, Chris Richardson, Ph.D., and Alan Kingstone, Ph.D., for their many helpful suggestions. I would also like to sincerely thank the many research assistants who contributed their invaluable time and effort to this project over the years.

I wish to acknowledge financial support for this work by the Canadian Tobacco Control Research Initiative, Canadian Institute of Heath Research, Michael Smith Foundation for Health Research and the Integrated Mentorship Program in Addictions Research.

Finally, special thanks are also owed to my parents, siblings and friends who have supported me in so many ways throughout my years of education. Thank you all for your strength, patience and senses of humor.

Chapter 1: Introduction

Cigarette smoking kills more than 45,000 Canadians each year and is responsible for over 20% of all deaths in Canada (Illing & Kaiserman, 2004). In 1996, smoking killed three times more Canadians than car accidents, suicides, drug abuse, murder and AIDS combined (Health Canada, 1996a; Illing & Kaiserman, 2004). Smoking also produces substantial health-related economic costs. In 1991, tobacco use was estimated to cost Canadians over $15 billion in health care, absenteeism and lost productivity (Health Canada, 1996b). Despite the significant health and economic costs associated with smoking, about 5 million Canadians (19% of the adult population) smoked daily or occasionally in 2007 (Health Canada, 2007).

The difficulty associated with cessation remains a significant obstacle to reducing smoking rates. Two weeks into a cessation attempt, approximately 62% of smokers relapse, and individuals who smoke any cigarettes at all after quitting have a 95% chance of resuming full-time smoking (Garvey, Bliss, Hitchcock, Heinold, & Rosner, 1992). All told, only 5% of smokers achieve long-term abstinence with a given quit attempt (Hughes, Keely, & Naud, 2004).

Nicotine cravings play a critical role in cessation difficulty. Desire to reduce craving is the most frequently cited reason for smoking among college students (Piasecki, Richardson, & Smith, 2007). Prospectively, craving severity predicts smoking relapse after accounting for level of nicotine dependence and several other well-known predictors of cessation success (Killen & Fortmann, 1997; West, Hajek, & Belcher, 1989). Momentary assessment studies suggest that smokers are more likely to lapse after experiencing intense, persistent and distressing cravings (Shiffman, Engberg, et al., 1997; Shiffman, Gnys, et al., 1996; Shiffman, Hickcox, et al., 1997). Identifying factors that influence craving severity is thus important for understanding and preventing cessation relapse.

Recent research from the study of metacognitive factors in psychopathology may provide a fresh perspective on this issue. Metacognition refers to how people think about and react to thoughts and impulses. Current theories propose that metacognition determines how

problematic unwanted thoughts become: individuals who interpret their thoughts as meaning something important (e.g., about their character or likelihood of acting on the thought) tend to be more disturbed by unwanted thoughts (Clark, Purdon, & Byers, 2000; Rachman, 1997; Salkovskis, 1989; Teachman, Woody, & Magee, 2006). Effort to avoid distress associated with unwanted thoughts compounds problems. In particular, thought suppression has been shown to paradoxically make thoughts rebound with greater frequency and elicit additional distress (Abramowitz, Tolin & Street, 2001). In theory, this rebound propels an escalating cycle of overly significant appraisal, personal distress and thought suppression that ultimately produces more frequent and upsetting thoughts, images and impulses (Rachman, 1997, 1998; Salkovskis, 1985). These models have been gaining empirical support in recent years and have led to the development of new interventions designed to reduce the persistence and distress associated with obsessions in obsessive-compulsive disorder (OCD; Purdon, Antony, & Summerfeldt, 2007; Rachman, 2003). Maladaptive metacognitive processes have also been implicated in several other psychological disorders characterized by distressing cognition, including other forms of anxiety, insomnia and psychosis (Cougle, Smits, Lee, Powers, & Telch, 2005; Harvey, 2001; Koster, Rassin, Crombez, & Naring, 2003; Morrison, 2005).

Preliminary evidence indicates that metacognitive models may also be relevant to understanding addictions. For example, Nosen and Woody (2009) found that individuals attempting to quit smoking experienced more frequent, distressing and persistent cravings if they concurrently viewed their smoking-related thoughts as more personally meaningful (e.g., as a portend of future behaviour or indicator of character) and important to control. Notably, these appraisals prospectively predicted whether participants would be smoking one month later after accounting for several other well-known predictors of cessation difficulty (e.g., cessation self-efficacy, depressive symptoms) and craving severity. The purpose of the present study is to continue this line of research. The following review will provide background on current conceptualizations of craving and established predictors before detailing the application of

metacognitive models.

1.1 Cravings: Intrusive Thoughts, Images and Impulses

Most researchers regard drug craving as a subjective and conscious phenomenon involving desire to use a substance (Sayette et al., 2000). Beyond this, researchers disagree about the best way to conceptualize and measure craving; see Sayette et al. (2000) for review. The World Health Organization (WHO) defines craving as a strong desire or compulsion to take a substance (WHO, 2006). Craving has also been conceptualized as a diffuse motivational state similar to hunger (Shiffman, 2000), a behavioural intention to use a substance (Buydens-Branchey, Branchey, Fergeson, Hudson, & McKernin, 1997), the desire for the effects of a drug (Marlatt, 1985), or as a combination of these motivational elements (Tiffany & Drobes, 1991).

Conceptualizing cravings experienced during cessation as a form of intrusive thought may be most useful in applications of metacognitive models. Intrusive thoughts, images and impulses have been broadly defined as "any distinct, identifiable, cognitive event that is unwanted, unintended, and recurrent. It interrupts the flow of thought, interferes in task performance, is associated with negative affect, and is difficult to control" (Clark & Rhyno, 2005, p. 4). Notably, no content is specified. Consistent with this definition, Shadel, Niaura, Brown, Hutchison and Abrams (2001) found that many smokers report a strong cognitive component to nicotine cravings, characterized by a thought, thought process, or an expectation of the consequences of smoking or not smoking. Indeed, individuals attempting to reduce their smoking frequently report experiencing distinct thoughts such as, "I would enjoy a cigarette right now," or "I can't cope without a cigarette," and images such as picturing oneself lighting up (Nosen & Woody, 2009; Salkovskis & Reynolds, 1994). Consistent with intrusive thoughts, cravings vary considerably over the course of a day and are spontaneously evoked by environmental cues (Shiffman, Engberg, et al., 1997; Shiffman, Gnys, et al., 1996). Cravings also interfere with other cognitive processes and can be very distressing (Cepeda-Benito & Tiffany, 1996; Zwaan, Stanfield, & Madden, 2000). Smoking urges have been associated with

reductions in working memory and information processing performance on both language comprehenion and mental arithmetic tasks (Madden & Zwaan, 2001; Sayette & Hufford, 1994; Zwaan et al., 2000; Zwaan & Truitt, 1998). Subjectively, cigarette cravings have been reported to be the most troubling withdrawal symptom experienced during the initial weeks of smoking abstinance (West, Hajek, & Belcher, 1989). Though people report that cravings decrease over time in both intensity and frequency, individuals who have been abstinent for months, and even years, report experiencing occasional upsetting and intrusive urges to smoke (Daughton et al., 1999; Gritz, Carr, & Marcus, 1991). Researchers have conceptualized cravings as a form of intrusive thought not only in nicotine research (e.g., Salkovskis & Reynolds, 1994), but also in research investigating cravings for alcohol, opiates, cocaine and food (Anton, Moak, & Latham, 1996; Malcolm, Herron, Anton, Roberts, & Moore, 2000; May, Andrade, Panabokke, & Kavanagh, 2004; Reynolds, Valmana, Kouimtsidis, Donaldson, & Ghodse, 2005; Tiggemann & Kemps, 2005; Tunis, Delucchi, & Hall, 1994).

1.2 Determinants of Cravings

What prompts intrusive thoughts about smoking among individuals attempting to quit? Researchers have developed a number of models to explain why individuals crave substances. The following section will briefly review some of the most common physiological, behavioural and cognitive factors affecting the frequency and intensity of nicotine cravings.

1.2.1 Neurophysiological Withdrawal Processes

Regular use of addictive substances creates a physiological cycle of dependence and withdrawal. Seconds after tobacco smoke is inhaled into the lungs, nicotine is absorbed into the blood stream and carried to the brain. Nicotine binds to nicotinic acetylcholine receptors and once present, triggers a cascade of chemical reactions; see De Biasi & Dani (2011) for review. For example, nicotine increases levels of dopamine in reward circuits in the brain, including the nucleus accumbens and mesolimbic dopamine system (Di Chiara, 2000; Picciotto, 1998; Pontieri, Tanda, Orzi, & Chiara, 1996). The brain quickly adapts to chronic exposure to nicotine,

creating a state of homeostasis that requires the presence of nicotine to function properly (De Biasi & Dani, 2011). When nicotine is removed, this neurochemical homeostasis becomes unbalanced and produces a withdrawal syndrome characterized by craving, nervousness, irritability, changes in heart rate, headache and impaired concentration (Hatsukami, Hughes, Pickens, & Svikis, 1984; Hughes, 2007; Hughes & Hatsukami, 1986; Hughes, Higgins, & Bickel, 1994; Morrell, Cohen, & al'Absi, 2008). Heavy smokers experience these withdrawal symptoms hours after their last cigarette (De Biasi & Salas, 2008; USDHHS, 1988). Symptoms typically return to baseline within 10 days of quitting smoking (Shiffman et al., 2006), although some studies indicate substantial individual differences in withdrawal trajectory (Hughes et al., 1994; Morrell et al., 2008). Thus, from a physiological perspective, cravings and smoking-related thoughts arise as part of the withdrawal process—essentially, cravings occur as the brain signals the smoker that it is missing something to which it has become accustomed.

1.2.2 Conditioning and Environmental Cues

The sights, smells and situations commonly associated with smoking also trigger strong cravings in smokers (Carter & Tiffany, 1999; Drummond et al., 1995). Classical conditioning models suggest that this phenomenon occurs because previously neutral environmental stimuli (e.g., lighters, presence of other smokers) begin to elicit conditioned craving responses (e.g., elevated heart rate, blood pressure, subjective urge) after repeated pairings with smoking (Stewart, de Wit, & Eikelboom, 1984; Tiffany, Drummond, Tiffany, Glautier, & Remington, 1995; Wikler, 1948). Consistent with these models, novel environmental stimuli can be classically conditioned to elicit craving in smokers (Lazev, Herzog, & Brandon, 1999). Robust and reliable cue-elicited craving effects have also been demonstrated in response to in vivo, imaginal, video and virtual reality smoking cues (Baumann & Sayette, 2006; Carter & Tiffany, 1999; Drummond et al., 1995; Lee et al., 2007; Tong, Bovbjerg, & Erblich, 2007).

While research on the role of external cues has predominated, interest in the role of internal cues for smoking is increasing (Niaura et al., 1988; Otto, Powers, & Fischmann, 2005).

Anger, stress, and depression are well-established situational precipitants of cessation lapse and relapse (Bliss, Garvey, Heinold, & Hitchcock, 1989; Shiffman, 2005; Shiffman et al., 2007). Abstinence from smoking has been shown to increase anxiety, irritability and sadness (Gilbert et al., 1998; Hughes, 2007; Zinser, Baker, Sherman, & Cannon, 1992); negative mood states in turn increase both urges to smoke and smoking behaviour (Brandon, Wetter, & Baker, 1996; Delfino, Jamner, & Whalen, 2001; Payne, Smith, Sturges, & Holleran, 1996; Shiffman, Gnys, et al., 1996). From a conditioning perspective then, cravings can be expected to arise in smokers whenever they encounter either an environmental cue (e.g., ashtray, driving in a car) or internal cue (e.g., stress) that has been regularly paired with smoking in the past.

1.2.1 Outcome Expectancies

Cognitive social learning theories (Marlatt, 1985; Marlatt & Gordon, 1985) suggest that expectations also appear to play an important role in determining craving severity. Outcome expectations refer to one's beliefs about the positive or negative consequences of using a drug. For example, an individual may come to believe that smoking helps him or her relax, that it alleviates boredom or that it helps him or her concentrate. In theory, craving is triggered any time the individual desires the expected outcome. Dynamic regulatory models of craving (Niaura, 2000) suggest that mood may influence craving through outcome expectancies, such that positive and negative affect triggers anticipation of pleasure and relief from drug use, respectively. Negative reinforcement models of addiction (Baker, Brandon, & Chassin, 2004) suggest that people use substances such as nicotine to avoid or reduce stress and negative affect. Consistent with these ideas, positive expectancies about the effects of smoking correlate with nicotine craving and predict smoking lapses (Cohen, McCarthy, Brown, & Myers, 2002; Gwaltney, Shiffman, Balabanis, & Paty, 2005; Niaura, Abrams, Monti, & Pedraza, 1989; Niaura, Shadel, Britt, & Abrams, 2002; Wetter et al., 1994). Smoking cigarettes also appears to ameliorate withdrawal-related negative affect (Gilbert, 1995; Zinser et al., 1992).

Thus, an individual who has recently given up smoking cigarettes can be expected to think

about smoking as a function of physiological withdrawal, upon encountering an internal or external reminder of smoking, and anytime he or she desires the perceived appetitive or relief effects of smoking. Nevertheless, much remains to be understood about psychological factors that affect the frequency, intensity and persistence of cravings. Kavanagh and colleagues, for example, recently noted, "the most pressing priority in the science of craving is understanding the observed variability in individuals' experience of craving" (2011, p.199). For example, what happens once an individual experiences an intrusive craving-related thought? Does the thought simply dissipate, passing fleetingly out of the mind just as quickly as it entered? Or does it persist, returning again and again until the individual gives into temptation? Why do some individuals manage to quit smoking relatively painlessly, while others struggle with unrelenting and distressing craving-related thoughts? Metacognitive models may provide insight into this issue.

1.3 Metacognitive Models of Psychopathology

Broadly defined, metacognition refers to "knowledge, processes and strategies that appraise, monitor or control cognition" (Spada, Nikčević, Moneta, & Wells, 2007, p. 2121). Metacognitive *knowledge* refers to beliefs about one's own cognitive and emotional states (Brown, 1987; Flavell, 1979; Wells, 2000; Yussen, 1985). For example, this includes beliefs that one has a good memory or beliefs that people who are successful, capable or strong willed should be able to control the content of their thoughts. Metacognitive *regulation* refers to the process of monitoring, planning, and checking cognitive performance (Brown, 1987; Flavell, 1979; Wells, 2000; Yussen, 1985). Noticing frequent thoughts about smoking and/or trying to figure out how to stop this are examples of metacognitive regulation. In simple terms then, metacognition refers to the ways people think about and respond to mental processes.

In recent years, researchers have been investigating how metacognition affects the intensity and persistence of intrusive thoughts. Metacognitive models have been developed to explain distressing cognition in a variety of disorders, including OCD, insomnia, generalized

anxiety disorder (GAD), psychosis, posttraumatic stress disorder (PTSD) and depression (Falsetti, Monnier, Davis, & Resnick, 2002; Falsetti, Monnier, & Resnick, 2005; Harvey, 2001, 2005; Morrison, 2005; Reynolds et al., 2005; Salkovskis & Reynolds, 1994; Wells, 2005a, 2005b; Wenzlaff, 2002). Two of the most widely studied metacognitive models of psychopathology are the cognitive theory of obsessions (Rachman, 1997, 1998; Salkovskis, 1985) and the Self-Regulatory Executive Function (S-REF) theory designed to explain generalized anxiety disorder (Wells & Matthews, 1994).

Briefly, these metacognitive theories suggest that the way people interpret an unwanted thought critically impacts the likelihood that such thoughts will be transient or persistent. Unwanted intrusions judged as important and personally relevant are theorized to be more distressing, more likely to elicit maladaptive coping responses, and consequently, more likely to recur (Rachman, 1997, 1998; Salkovskis, 1985; Wells, 2000). These ideas will first be discussed in a general context; applications to understanding smoking cravings and cessation difficulty follow.

1.3.1 Maladaptive Appraisals and Metacognitive Beliefs

Within the stress and coping literature, cognitive appraisal is defined as a process of evaluating the relevance and likely impact of a stressor on personal well-being (Lazarus & Folkman, 1984). Researchers of obsessions have highlighted several types of appraisals believed to be important in the development of frequent and distressing intrusive thoughts, including overestimation of the personal significance of the thought (e.g., *this thought means I am a bad person)*, "thought-action fusion" or flawed beliefs about the strength of the connection between thoughts and actions (e.g., *having this thought means I will undoubtedly act on it)*, and an unrealistic desire to maintain perfect thought control (e.g., *I must control this thought;* (Clark & Purdon, 1993; Freeston, Ladouceur, Thibodeau, & Gagnon, 1991; Obsessive Compulsive Cognitions Working Group (OCCWG), 1997, 2001, 2003). S-REF theories implicate unfounded beliefs about both the benefits and dangers of worrying, lack of confidence in one's own

attention and memory ("cognitive competence"), increased tendency to monitor and attend to one's thoughts, and beliefs that thoughts need to be controlled (Wells, 2000).

Research on obsessive thoughts suggests that personally meaningful appraisals of unwanted thoughts encourage negative self-evaluation and are associated with intrusion frequency, uncontrollability and discomfort with thought recurrence (Clark et al., 2000; Clark, Purdon, & Wang, 2003; Purdon & Clark, 1994a, 1994b; Teachman et al., 2006). Prospectively, overly meaningful appraisals predict obsessive-compulsive symptoms (Abramowitz, Nelson, Rygwall, & Khandker, 2007). In other forms of psychopathology, the tendency to assume equivalence between thoughts and action (i.e., "thought-action fusion") has been found at elevated levels in individuals with depression, generalized anxiety, and eating disorders (Abramowitz, Whiteside, Lynam, & Kalsy, 2003; Muris, Meesters, Rassin, Merckelbach, & Campbell, 2001; Shafran, Teachman, Kerry, & Rachman, 1999). Negative appraisals of the personal meaning of unwanted intrusive cognition, including the specific beliefs described by S-REF theories, have also been associated with distress and symptom severity in hypochondriasis, PTSD, depression, and psychosis (Bouman & Meijer, 1999; Gwilliam, Wells, & Cartwright-Hatton, 2004; Morrison, 2001; Myers & Wells, 2005; Papageorgiou & Wells, 2003; Roussis & Wells, 2006; Starr & Moulds, 2006; Steil & Ehlers, 2000).

1.3.2 Maladaptive Responses to Unwanted Intrusions

According to metacognitive models, personally meaningful interpretations of unwanted thoughts are distressing and likely to elicit maladaptive coping responses such as thought suppression (i.e., actively trying not to think about a certain topic) and rumination (i.e., fixating attention on the presence and meaning of symptoms; Nolen-Hoeksema, 1991; Rachman, 1997, 1998; Salkovskis, 1985; Wells, 2000). Thought suppression and rumination are hypothesized to have both common and unique effects that contribute to problems. Both coping responses are hypothesized to increase self-focused attention, increase the accessibility of negative information about the self and prevent change in maladaptive metacognitive beliefs (Nolen-

Hoeksema, 1991; Wells, 2000). As for unique effects, attempting to avoid the discomfort associated with unwanted thoughts by suppressing them can paradoxically make the thoughts recur with greater frequency (Abramowitz, Tolin, & Street, 2001; Wegner, Schneider, Carter, & White, 1987). This rebound is theorized to confirm initial concerns about the importance and personal meaning of the thought and strengthen desire for control, beginning an escalating cycle of distress, vigilance, and unsuccessful suppression (Clark & Purdon, 1993). Rumination is specifically posited to exacerbate and prolong distress, increase the probability of negative interpretations of stimuli and situations, and impede instrumental problem solving (Nolen-Hoeksema, 1987, 1991).

Empirical studies of the effects of suppression and rumination generally support these hypotheses. Individuals with OCD engage in frequent unsuccessful attempts to suppress unwanted thoughts (Purdon, Rowa, & Antony, 2007). Implying a mediational process, several correlational studies have confirmed that the relationship between personally meaningful appraisals of unwanted thoughts and OCD symptoms declines when thought suppression is taken into account (Rassin, Muris, Schmidt, & Merckelbach, 2000; Smári & Hólmsteinsson, 2001). Thought suppression has also been correlated with symptoms of PTSD, agoraphobia, depression, and insomnia (Ehlers, Mayou, & Bryant, 1998; Fehm & Margraf, 2002; Harvey, 2001; Wenzlaff & Luxton, 2003).

Rumination appears similarly problematic. Prospectively, the tendency to ruminate predicts symptoms of anxiety and depression as well as the onset of major depressive episodes (Calmes & Roberts, 2007; Just & Alloy, 1997; Nolen-Hoeksema, 2000). Experimental studies show that rumination causally affects mood. Induction of worry and rumination among normal participants increases negative affect, anxiety and depression (Andrews & Borkovec, 1988; Behar, Zuellig, & Borkovec, 2005; McLaughlin, Borkovec, & Sibrava, 2007; Wells & Papageorgiou, 1995; York, Borkovec, Vasey, & Stern, 1987). In individuals who are already feeling dysphoric, rumination exacerbates negative mood, triggers negative autobiographical

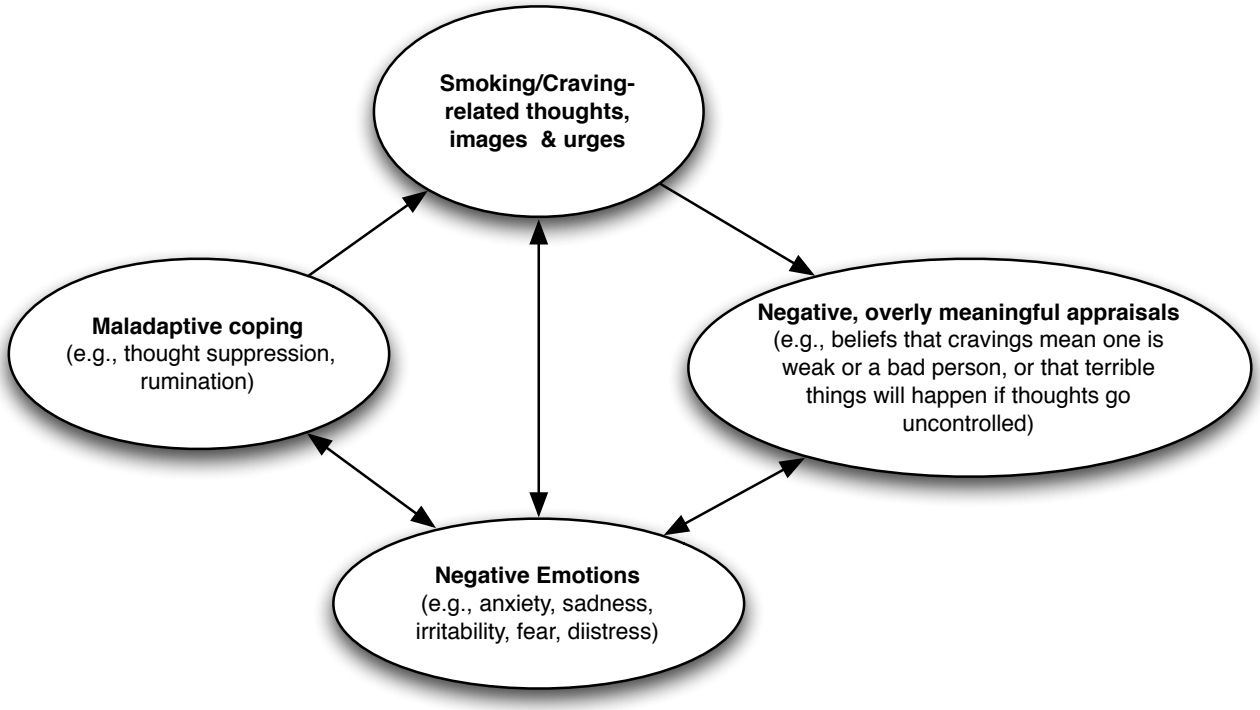
memories, increases negative thinking about the future, and elicits more negatively distorted interpretations of situations (Lavender & Watkins, 2004; Lyubomirsky, Caldwell, & Nolen-Hoeksema, 1998; Lyubomirsky & Nolen-Hoeksema, 1995). Supporting the processes suggested by metacognitive models, beliefs that worrying can be helpful predicts ruminative tendencies, which in turn are associated with depressive symptoms (Papageorgiou & Wells, 2003).

1.4 Metacognition, Cravings and Smoking

1.4.1 Metacognitive Model of Cravings

Metacognitive models may also help explain why some people struggle more than others with cravings during smoking cessation. Figure 1 illustrates the application of this model to cravings. This model begins with the premise that nearly everyone attempting to quit smoking experiences nicotine cravings in the form of smoking and craving-related thoughts, images and urges during cessation (top oval in Figure 1). It goes on to suggest that the way people interpret or appraise cravings may be an important determinant of future cravings. Specifically, individuals who appraise their craving-related thoughts in negative, overly personal or catastrophic ways (i.e., as meaning that they are weak-willed, destined to fail, or out of control; right oval in Figure 1) are likely be more distressed by cravings (bottom oval in Figure 1). In turn, increases in sadness, anxiety and irritability (i.e., distress) exacerbate urges to smoke to relieve negative affect (middle arrow in Figure 1) and encourage unhelpful coping responses like suppression and rumination (left oval in Figure 1). Due to the paradoxical effects of suppression, increased attentional focus on cravings, and further distress at failures to control thoughts, responses such as suppression and rumination are theorized to further exacerbate smoking-related thoughts and urges to smoke, and negative emotions. Finally, reappearance of the craving strengthens and confirms appraisals of the importance of the thought, encouraging an escalating cycle of distress, maladaptive responses and cravings.

Figure 1. Metacognitive Model of Cravings



1.4.1 Metacognitive Model Fit with Established Predictors of Cravings

While cravings have not previously been explicitly conceptualized using a metacognitive model, this model fits well with existing theories of cravings. Established determinants of cravings, such as physiological withdrawal processes, environmental cues and outcome expectancies, could be considered as triggers that prompt initial thoughts about smoking and initiate the appraisal process. According to metacognitive models, these appraisals and subsequent responses then help determine whether smoking-related thoughts are transient or more persistent. In this respect, metacognition could be considered a higher order determinant of cravings.

Metacognitive models also complement several established determinants of relapse. Efficacy expectations, for example, refer to one's confidence in his or her ability to cope (i.e., abstain from drug use) in a particular situation (e.g., I can/can't resist smoking when I'm upset)

and are considered central to successful behaviour change (Bandura, 1977). Cognitive social learning theories propose that expectancies interact to create relapse risk, such that risk for relapse is greatest when efficacy expectations are low and positive expectations about drug use are strong (Marlatt & Gordon, 1985; Niaura, 2000). Beliefs that cravings are personally significant and meaningful (e.g., a sign one is weak), that cravings are similar to actual smoking and an indication of relapse (i.e., thought-action fusion) and that cravings can and should be perfectly controlled, may erode confidence in one's ability to abstain from smoking in high-risk situations. Distress associated with appraisals and thought control failure may similarly elicit expectancies that smoking will relieve negative affect, and consequently, future smoking behaviour. These ideas are similar to Marlatt's (1985) suggestion that deficient coping responses to cravings lead to decreased situational cessation self-efficacy and increased positive outcome expectations for substance use.

The metacognitive model also complements recent interest in anxiety sensitivity (i.e., fear of internal anxiety-related sensations) and distress tolerance (i.e., ability to withstand physiological, psychological and emotional discomfort) as a component of cessation success. Essentially, these constructs all imply that reactions to withdrawal symptoms may be more important than the experience of the withdrawal symptoms per se (Brown et al., 2008). Consistent with this premise, anxiety sensitivity predicts early relapse from smoking cessation and correlates with increased expectations that smoking will relieve negative affect and with decreased confidence in cessation ability among current daily smokers (Brown, Kahler, Zvolensky, Lejuez, & Ramsey, 2001; Gregor, Zvolensky, Bernstein, Marshall, & Yartz, 2007; Zvolensky et al., 2007; Zvolensky et al., 2006). Persistence on physiological and cognitive challenge tasks (e.g., inhalation of carbon dioxide and speeded mental arithmetic) also predicts subsequent time to smoking cessation lapse (Brandon et al., 2003; Brown, Lejuez, Kahler, & Strong, 2002). Thus, there is some evidence to suggest that reaction to withdrawal symptoms may affect cessation difficulty.

Empirical investigation of the metacognitive model is important, not only because it provides a novel way to conceptualize substance use urges, but also because it implies that modification of maladaptive beliefs and responses may be valuable clinical tools. Accordingly, the purpose of the current study is to test several key tenets of this model among tobacco smokers. The following sections will review existing evidence for the role of metacognition in determining craving severity and clarify areas requiring research.

1.4.2 Maladaptive Appraisals of Cravings

Relatively little research has investigated metacognition in substance use and addiction. However, preliminary evidence suggests that theoretically maladaptive appraisals and metacognitive beliefs are both prevalent and detrimental among substance users. Spada and colleagues have found positive correlations between metacognitive beliefs and alcohol use in both clinical and non-clinical samples (Spada & Wells, 2005; Spada, Zandvoort, & Wells, 2007). Compared to community controls, problem drinkers endorse stronger beliefs in the usefulness of worry, the uncontrollability and danger of worry, and the need to control thoughts (Spada, Zandvoort, et al., 2007). Beliefs that thoughts need to be controlled consistently predict alcohol use independent of anxiety and depression (Spada & Wells, 2005; Spada, Zandvoort, et al., 2007). Hoyer and colleagues (2007) examined appraisals of alcohol-related thoughts, memories and images among 144 recently abstinent individuals meeting DSM-IV criteria for alcohol abuse. Consistent with metacognitive models, they found that appraisals of alcohol-related intrusions as unpleasant (e.g., “this thought disturbs me”) and as uncontrollable and linked to action (e.g., “this thought is stronger than my will”; “this thought can really make me drink”) correlated with increased craving, greater tendencies to suppress alcohol-related thoughts, more severe depressive symptoms, and decreased cessation self-efficacy. Beliefs like “once craving starts I have no control over my behaviour” and “cravings can drive you crazy” have also been shown to predict abstinence status among treatment-seeking methamphetamine users (Lee, Pohlman, Baker, Ferris, & Kay-Lambkin, 2010).

Metacognitive appraisals also appear relevant to nicotine dependence. In interviews with ex-smokers who called a relapse prevention counseling hotline, Shiffman (1984b) found that self-punitive thoughts related to the relapse crisis (e.g., “I’m such a weakling”) were associated with significantly more relapse than any other coping strategy and were the only strategy no more effective than not coping at all. This finding indicates that some smokers may view cravings as a negative self-reflection, and that this type of negative appraisal may be detrimental to cessation success. In a different study, Shiffman (1984a) also showed that individuals who face a relapse crisis, in which they are tempted to (but do not) smoke, experience declines in their abstinence self-efficacy and feelings of failure similar to those who actually do lapse. This suggests that a form of thought-action fusion may occur in some individuals whereby cravings are appraised as comparable to actual smoking and an indication of likely cessation failure.

Consistent with these findings, Spada, Nikčević et al. (2007) found positive correlations between nicotine dependence and three types of S-REF metacognitive beliefs (positive beliefs about worry, negative beliefs about the uncontrollability and danger of worry and cognitive confidence) in a sample of undergraduate smokers. Using structural equation modeling, metacognition emerged as a significant partial mediator of the relationship between negative emotions and level of nicotine dependence. In a subsequent study, Nikčević and Spada (2008) compared high-dependency smokers, low-dependency smokers and non-smokers on the Metacognition Questionnaire (MCQ). They found that high-dependency smokers reported more positive beliefs about worry than non-smokers, and beliefs about the need to control thoughts predicted logistic regression classification as a dependent smoker.

Nosen and Woody (2009) recently investigated metacognition in a correlational study of smokers reporting that they are currently attempting to quit and had initiated this cessation attempt within the past 6 months. This study confirmed that many smokers attempting to quit endorse some degree of beliefs that smoking-related thoughts mean that they are weak, that

their attempt to quit smoking is destined to fail, and that it is important to block the thoughts. A substantial minority of individuals took their appraisals even further, endorsing beliefs that smoking-related thoughts mean that they are out of control or that the thoughts will lead to insanity, punishment or condemnation. In line with metacognitive models, this study found that participants experienced more frequent, distressing and persistent cravings if they concurrently appraised their smoking-related thoughts in these negative, personally meaningful ways. Or put another way, participants appraised their thoughts in overly negative ways when experiencing more frequent, distressing and persistent craving-related thoughts. Significant correlations were also observed between appraisals of cravings and cessation self-efficacy, depression, thought suppression and smoking expectancies. Importantly, personally meaningful appraisals of cravings also prospectively predicted whether participants would be smoking one month later after accounting for other predictors of cessation difficulty.

Thus, preliminary evidence suggests some individuals attempting to quit smoking appraise craving-related thoughts as important signals of the type of person they are or the likely success of their quit attempt, and these beliefs correlate with problematic substance use in studies of both nicotine and other substance dependence. That said, existing literature on this topic is sparse, and several methodological limitations exist. For one, appraisals of nicotine cravings have predominantly been assessed by a measure designed to assess metacognitive beliefs relevant to Generalized Anxiety Disorder (Metacognitive Beliefs Questionnaire; Wells, 2000), with only one study using a measure designed to assess specific appraisals of smoking-related thoughts (Appraisals of Craving Questionnaire (ACQ); Nosen & Woody, 2009). It is unclear how these two measures relate to each other or what the psychometric properties of the ACQ are in a different sample. As such, continued development of a smoking-specific appraisal measure is warranted, both to affirm the robustness of previously observed correlations and to facilitate continued research on metacognitive beliefs. In addition, no studies to date have examined metacognitive beliefs among smokers in the early days of a cessation attempt,

despite the fact that many smokers lapse within this time frame (Allen, Bade, Hatsukami, & Center, 2008; Shiffman, Paty, Gnys, Kassel, & Hickcox, 1996; Spanier, Shiffman, Maurer, Reynolds, & Quick, 1996). In Nosen and Woody's (2009) study, for example, only a small proportion of the sample reported being in the initial days of cessation. Thus, the relevance of metacognitive models to this critical time period is uncertain. The first aims of the current study are therefore to continue development of the ACQ and to replicate previously observed correlations among a biochemically verified sample of smokers in the early days of cessation.

Longitudinal and experimental studies are also needed to establish the temporal and causal directions underlying these relationships. Metacognitive theories suggest that maladaptive beliefs increase distress and cravings. However, metacognitive beliefs may just as easily be a consequence, rather than cause, of cessation difficulty. Specifically, nicotine withdrawal increases both cravings and negative affect (Hughes, 2007). Consistent with mood-congruent information processing effects, distress may encourage people to think about their cravings in more negative, overly catastrophic ways. Similarly, experiencing recurrent cravings or lapses during cessation may strengthen or confirm worries about the meaning of the smoking-related thoughts (e.g., *"The fact that this urge keeps returning proves that it really <u>does</u> mean something about me / that I'm destined to fail / that I'm not fighting hard enough*"). Both directional pathways may also be operating, such that maladaptive appraisals, severe cravings and negative mood form reciprocal relationships that propel an escalating cycle of distress and craving. These bidirectional relationships are not made explicit in the metacognitive models developed within the context of obsessions or other psychological disorders, and accordingly, have not been tested. Nevertheless, understanding the temporal and causal relationships underlying correlations between cravings and metacognitive beliefs is essential both for furthering conceptualizations of cravings and for clarifying the potential utility of clinical interventions focused on reducing maladaptive beliefs. The second goal of the current study is accordingly to begin disentangling the directionality of previously observed correlational

relationships.

1.4.3 Maladaptive Responses to Cravings

Further research is also required to identify the mechanisms underlying the effects of metacognitive appraisals on craving severity. Theoretically, overly meaningful appraisals are problematic because they elicit distress and maladaptive coping responses (e.g., suppression, rumination), which in turn exacerbate intrusion frequency, increase the accessibility of negative self-referent information and prevent corrective learning (Rachman, 1997, 1998; Salkovskis, 1985; Wells, 2000). Empirically, however, findings on the effects of different cognitive coping strategies have been mixed.

Correlational studies of real time self-reported coping during smoking cessation generally indicate that cognitive coping strategies are common and efficacious responses to smoking urges, with very few differences observed between specific strategies. For example, O'Connell, Hosein, Schwartz, and Leibowitz (2007) used ecological momentary assessment to assess the impact of coping strategies on urge levels before and after temptations to smoke during the first few weeks of smoking cessation. They found that participants used a variety of cognitive and behavioural strategies; the most common cognitive coping strategies included "prohibiting smoking", "encouraging and calming self-talk", thinking of the "negatives of smoking/benefits of quitting", "focusing thoughts away from smoking", and "optimism about success in quitting". They found that each of these strategies protected against lapses but was no better or worse than the average strategy. Other momentary assessment and retrospective studies have found similar consistency in cognitive coping strategy efficacy, such that any cognitive coping appears better than no coping (and equivalent to behavioural coping), and that specific cognitive strategies are generally not differentially related to urge resistance (Bliss et al., 1989; Ortendahl & Nasman, 2007; Shiffman, 1984b; Shiffman, Gnys, et al., 1996). Among the few exceptions to this rule, Shiffman (1984b) found that punitive self-talk (as previously discussed) and "willpower" were less effective than other cognitive and behavioural coping

strategies.

Of course, failures to find differential strategy effects may in part be a function of how coping strategies are assessed and categorized. To simplify analyses, most researchers group strategies under broad conceptual headings – thus, thought suppression may be categorically lumped with strategies like "distraction" or "general cognitions" or "willpower", depending on the research team. Similarly, a category like "focusing thoughts away from smoking" may include both thought suppression and strategies such as attentional refocusing. Shadel, Niaura, Goldstein and Abrams (2001), for example, experimentally instructed participants to implement "cognitive avoidance coping" in response to smoking cues by asking them to "concentrate and focus on something else in your own mind" (p. 173). Again, this seems similar, but not altogether congruent, with suppression.[1] Rumination is also unlikely to be accounted for in these studies as it is not routinely listed in researcher-provided coping strategy checklists, and it may not be considered an actively implemented "coping strategy" per se by research participants (i.e., it may be something that people do without conscious thought).

Direct investigations of the role of thought suppression in addictive behaviours have produced ambiguous results. Salkovskis and Reynolds (1994) examined the effects of suppression in a sample of individuals attempting to quit smoking. They found that *all* individuals attempting to reduce their smoking reported trying to suppress smoking-related intrusive thoughts or images to some extent over the previous month. They relied on a single retrospective item in this assessment, however, raising questions about reliability and validity. Similar to research on obsessive thoughts, this same study found individuals who were instructed to suppress intrusive thoughts about smoking subsequently experienced more frequent intrusions than did individuals instructed to either monitor their thoughts or monitor and relax. However, Reynolds et al. (2005) failed to replicate this experimental effect in a study of

[1] Unfortunately, the authors did not directly compare this strategy with no coping.

drug-related thoughts among individuals recovering from opiate or multi-substance dependence in an inpatient treatment center. Similarly, Erskine and colleagues (2011) found that instructed suppression of smoking-related thoughts did not increase urge to smoke or withdrawal symptoms 5 to 10 minutes post-suppression, relative to those asked to express or monitor. Studies of behavioural rebound are similarly mixed. Palfai and colleagues, for example, found that suppression of alcohol-related urges increased the accessibility of alcohol outcome expectancies, and they also observed a cross-substance effect whereby suppressing alcohol-related urges increased the intensity of cigarette smoking in current smokers (Palfai, Colby, Monti, & Rohsenow, 1997; Palfai, Monti, Colby, & Rohsenow, 1997). While this cross-substance effect suggests urge suppression may have important behavioural consequences, the mechanisms driving this effect are unclear. Two more recent studies only modestly clarify the picture. Instructed suppression over the course of a week has been shown to increase smoking behaviour during the subsequent week, relative to those asked to express or monitor smoking thoughts (Erskine et al., 2011). However, Rogojanski, Vettese and Antony (2011a) found that instructing people to suppress cue-elicited urges actually decreased smoking behaviour at one week-follow up, similar to practicing mindful responses. Mindfulness did reduce negative affect more than suppression, however, which is consistent with metacognitive models.

Correlational studies on smokers' use of thought suppression while quitting have also produced mixed results. Based on the idea that thought suppression may make quitting smoking more difficult, Toll, Sobell, Wagner, and Sobell (2001) found that current smokers (termed "unsuccessful quitters") scored higher on a general measure of thought suppression than did ex-smokers (i.e., "successful quitters"). This study used the full-scale White Bear Suppression Inventory (WBSI) as an index of general thought suppression. However, researchers have recently found that this measure actually contains two subscales, only one of which assesses suppression (Höping & de Jong-Meyer, 2003; Rassin, 2003). Use of the full scale, which includes a factor reflecting problems with intrusive thoughts, may artificially inflate

apparent relationships with psychopathology (Höping & de Jong-Meyer, 2003). Further, this measure asks about general avoidance of thoughts (e.g., "how much do you avoid certain thoughts"), not specific avoidance of smoking-related thoughts (e.g., "how much do you avoid *smoking*-related thoughts). This makes results hard to interpret, despite the measure's widespread usage. Indeed, Haaga and Allison (1994) assessed suppression by coding thoughts articulated in response to various imagined high temptation situations and found no association between the use of thought suppression strategies and maintenance of non-smoking over a one-year period. Nosen and Woody (2009) also found that tendency to suppress unwanted thoughts, assessed using the suppression factor of the WBSI scale, did not contribute significantly to the prediction of either concurrent craving severity or one-month cessation outcome.

Thus, measurement of thought suppression in substance users is an issue that limits existing work. How do scores on the WBSI relate to distraction, worry, punishment and other responses to unwanted thoughts? To what extent are cravings related to suppression of *smoking*-related thoughts, as opposed to avoidance of the variety of other kinds of intrusive thoughts potentially assessed via the WBSI? In addition to these measurement issues, no studies have investigated thought suppression in the early days of smoking cessation, despite the fact that this is likely the time when suppression is implemented most naturally. Complicating the picture, nicotine withdrawal impairs concentration and increases negative affect (Piper & Curtin, 2006; Wenzlaff, Wegner, & Roper, 1988), both potentially making suppression more difficult (Conway, Howell, & Giannopoulos, 1991; Edwards & Dickerson, 1987; Sutherland, Newman, & Rachman, 1982; Wenzlaff et al., 1988). Attention also needs to be paid to individual differences in the level of distress caused by suppression efforts. Individuals craving cigarettes, for example, may be upset by suppression rebound, but they may also become anxious at the prospect of permitting smoking-related thoughts in a non-smoking environment or during a cessation attempt. Overall then, it is not clear how normative thought

suppression is during a cessation attempt, nor is it known how natural use of suppression relates to cessation success.

Turning now to other types of potentially problematic metacognitive responses, only a few studies have examined the impact of rumination on substance use; only one of these focuses on smoking. Generally, these studies have found that rumination is associated with poorer substance abuse outcomes. For example, longitudinal research suggests that adolescents who ruminate in response to stress are at greater risk for future substance abuse and substance misuse following negative events (Nolen-Hoeksema, Stice, Wade, & Bohon, 2007; Skitch & Abela, 2008). Rumination is also a significant predictor of alcohol problems among women (Nolen-Hoeksema & Harrell, 2002). Richmond, Spring, Sommerfield and McChargue (2001) conducted the sole study of rumination and smoking. In this cross-sectional, retrospective study of university students, rumination was more strongly correlated with depression among smokers than among non-smokers. It is not clear from this study whether the observed associations arose from shared vulnerability factors or from causal effects of rumination, negative affect or smoking. Further research is required to understand the extent to which individuals trying to quit smoking ruminate about cravings and the relationship rumination may have to craving severity, negative affect and other variables pertinent to cessation difficulty.

1.5 Current Work

1.5.1 Overview

As described, there are three primary aims of the current study. First, I aim to replicate previously observed cross-sectional correlations between cravings, distress and metacognitive beliefs in a biochemically verified sample of community smokers (both smoking regularly and attempting to quit). Second, I intend to begin disentangling the directionality of these correlational relationships by examining the causal effect of receiving information discouraging negative, personally significant appraisals of cravings on urge severity during smoking cessation, as well as the reciprocal effect of cessation on maladaptive appraisals. Third, I aim to

examine the relationship between metacognitive responses (thought suppression, punishment, worry and rumination) and cessation relevant variables. Towards this goal, both smoking cessation and metacognition were experimentally manipulated; impact on urge to smoke, metacognition, distress and other theoretically relevant variables were observed over the course of several days.

Smokers interested in quitting were randomly assigned to one of two cessation conditions: smoking cessation attempt started (lab sessions encompass first few days of cessation) vs. anticipated (lab sessions prior to cessation). When arriving at the lab, participants were assigned to one of three interactive computer-based psychoeducation conditions (metacognitive vs. non-metacognitive vs. no psycho-ed control). The *metacognitive* condition aimed to reduce and correct maladaptive appraisals and responses to craving-related thoughts, images and impulses. For example, participants were informed that cravings are normative, transient phenomena that do not mean anything personally significant about one's character and do not need to be perfectly controlled. The *non-metacognitive* control condition provided psychoeducation about risk factors for smoking and commonly used cessation techniques, in the interest of matching the metacognitive condition's level of information, time, participant involvement, and perceived relevance to cessation. The *no psychoeducation* control condition provided a comparison group who did not receive an interactive psychoeducation intervention.

Dependent variables were measured with questionnaires completed during lab sessions, and via ecological momentary assessments (in vivo cravings over the course of three days) to reduce retrospective recall bias. While the primary focus of this work is on understanding nicotine cravings, cessation success was also assessed via self-report one month after the participants' quit date.

1.5.2 Hypotheses

Metacognitive theories predict that appraisals of craving-related thoughts as personally meaningful and important to control will result in increased distress, problematic responses to

cravings (i.e., suppression, rumination, worry and punishment) and severity of craving during smoking cessation (see Figure 1). Concurrently then, positive correlations were expected between metacognitive beliefs, distress, responses and craving severity, among both regular smokers and individuals attempting to quit.

The metacognition psychoeducational manipulation also permits examination of the converse form of the directionality conjecture; specifically, I hypothesized that providing information discouraging appraisals of craving-related thoughts as personally meaningful and necessary to control would decrease distress, problematic responses to nicotine cravings (i.e., suppression and rumination) and severity of cravings during smoking cessation, relative to control conditions.

As discussed, it is also plausible that increases in the frequency and intensity of nicotine withdrawal-related distress and cravings may cause people to think more negatively about their cravings and quit attempt and therefore encourage maladaptive appraisals of cravings. The cessation start manipulation provided a test of the impact of nicotine withdrawal on metacognition. I hypothesized that increased craving, withdrawal and distress associated with beginning a cessation attempt would increase beliefs that cravings are personally meaningful and important to be controlled.

Finally, metacognitive models suggest that thought suppression is a problematic coping response that ironically makes unwanted thoughts recur more frequently. However, as previous studies have produced mixed results regarding the maladaptive nature of suppression during cessation, further research is required to understand this phenomenon. Towards this end, I examined how thought suppression relates to other forms of metacognitive responses (e.g., distraction, punishment, worry, rumination) using factor analytic techniques. Investigating this further, I examined how suppression, rumination and other metacognitive responses relate to cessation related variables (craving severity, withdrawal, negative affect) and whether there are differences in frequency of use by individuals smoking regularly and those attempting cessation.

To the extent that suppression is a “problematic” response style, it would be expected to share significant common variance with punishment, rumination and the like, to correlate positively with craving severity, withdrawal and distress, and to be used more frequently by individuals who are ultimately unsuccessful in their attempt to quit smoking.

The subsequent chapters describe the implementation and results of this study. Chapter 2 describes the methods in full detail. As there are multiple aims and design elements within this project, Chapters 3 - 7 describe analyses of specific research questions (i.e., in-depth attention to measure development, concurrent relationships, experimental analyses, longitudinal relationships and response styles). For each of these analytic chapters, relevant elements of the background literature, rationale and methods are briefly repeated for the reader’s reference; the reader may wish to either skim these sections or return to Chapters 1 and 2 for complete details on the rationale and methods, as warranted.

Chapter 2: Methods

2.1 Design Overview

The current project was a 3 x 2 between-subjects experimental design with three levels of metacognition manipulation (metacognitive psychoeducation vs. cessation psychoeducation control vs. no psychoeducation control) and two levels of cessation manipulation (cessation attempt started vs. anticipated). Assignment to condition was random under the constraint of equal groups. A longitudinal, ecological momentary assessment component was embedded within the design.

Initiation of a cessation attempt was chosen as the craving and withdrawal induction method because previous research has shown that cigarette cravings increase significantly within the first 24 hours of abstinence among individuals attempting to quit smoking (Hughes & Hatsukami, 1986; Shiffman, Engberg, et al., 1997; West & Schneider, 1987). While less intensive craving inductions methods are commonly used in research (e.g., 12-hour abstinence), craving in the context of smoking cessation is both more ecologically valid and likely to impact metacognitive processes (as maladaptive beliefs about cravings may be less salient when participants know they will be smoking again soon enough).

Participants then completed three days of monitoring cravings and smoking behaviour. They returned to the lab afterwards to return their monitoring forms and complete additional outcome measures. The brief, three day follow-up interval was selected because the primary aim of the current study is to understand processes influencing craving, not relapse per se. Cravings are strongest on the day of cessation and decline considerably in the days following (Shiffman, Engberg, et al., 1997). Thus, a short sampling period was chosen to maximize participant compliance and minimize attrition. Even so, this time frame still permits some examination of relapse processes. Many smokers relapse within the first 24 hours of quitting (Allen, Bade, Hatsukami, & Center, 2008; Shiffman, Paty, Gnys, Kassel, & Hickcox, 1996; Spanier, Shiffman, Maurer, Reynolds, & Quick, 1996). Allen and colleagues (2008), for

example, found that 41% (117 participants) of their sample relapsed within 24 hours post-cessation. To supplement understanding of longer-term cessation outcomes, participants also completed a brief follow-up survey via email or phone one month after their intended cessation date.

2.2 Participants

Participants were English-speaking adult smokers from Canada. As inclusion criteria, participants were required to report smoking at least an average of 10 cigarettes/day for the past two years. Current smoking status was confirmed biochemically during the first lab session (breath carbon monoxide (CO) levels over 8ppm; Benowitz et al., 2002). Participants also needed to agree to make a serious effort to quit smoking on a date decided upon in collaboration with the researchers. Participants were excluded if they reported probable past year alcohol or substance dependence during a brief telephone-screening interview (score above 5 on the Brief-MAST (Pokorny, Miller, & Kaplan, 1972) or score above 2 on the DAST-10 (Cocco & Carey, 1998; Maisto, Carey, Carey, Gordon, & Gleason, 2000; Skinner, 1982). Participants were recruited from the community and received a $40 honorarium for their participation ($20 per lab session). Study advertisements offered smokers interested in quitting the opportunity to take part in a study of the psychological processes involved in cessation and to receive a small honorarium; treatment was not mentioned in the advertisements.

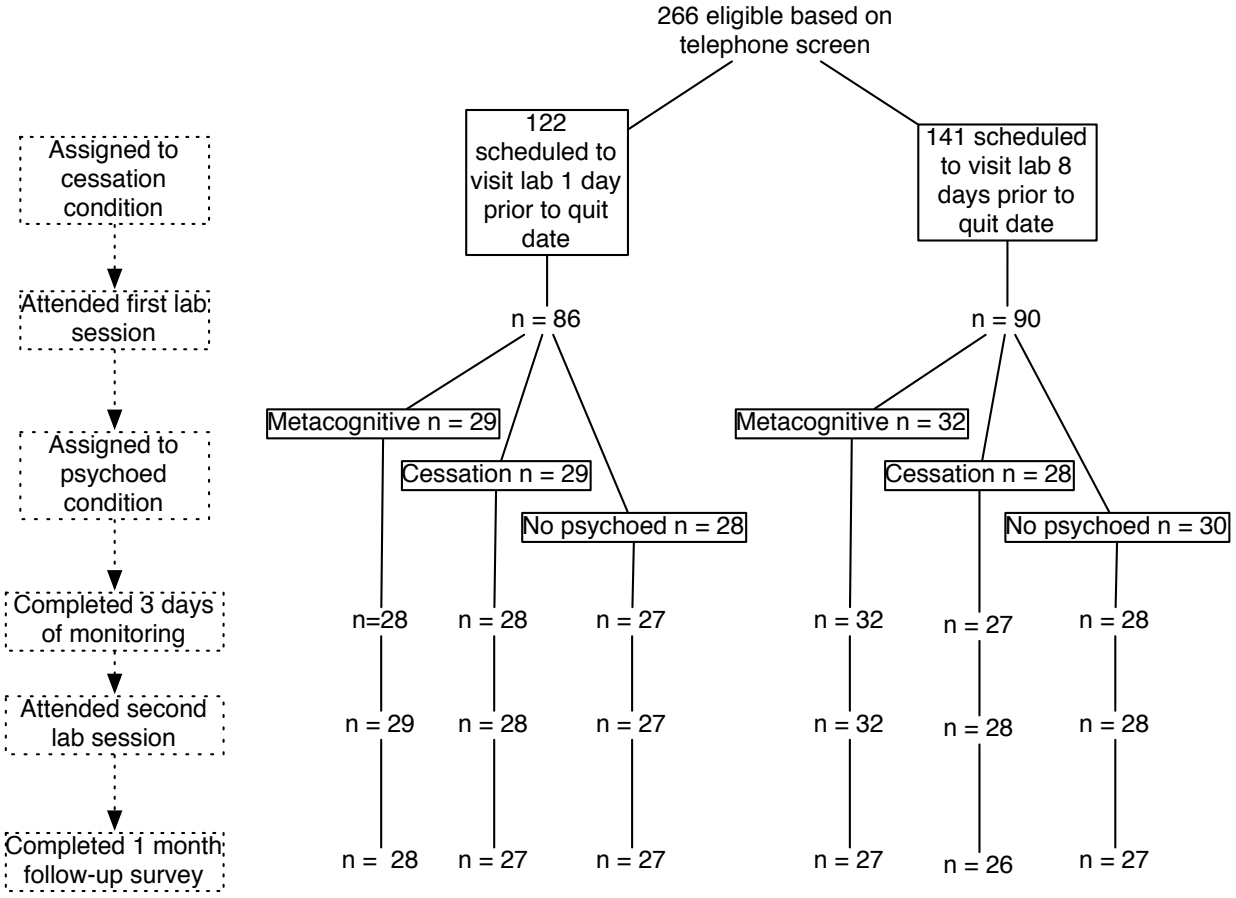
At least 25 participants with complete data (i.e., including one-month follow-up) were sought for each cell of the 3 x 2 design. As data collection continued while follow-ups were pending for final participants, a few extra participants were recruited in all conditions during this time. Figure 2 illustrates the progression of participants through the study. Of the 266 participants eligible for the study after telephone screening, 176 participants (66%) attended

their first scheduled lab appointment and passed the breathalyzer screening[2]; this is on par with other studies recruiting a community sample of individuals attempting to quit smoking (Kamholz, Gulliver, Helstrom, & Morissette, 2009). Of eligible individuals attending the first lab session, 172 (97.7%) and 162 (92.0%) completed the second lab session and one-month follow-up, respectively. Monitoring booklets were returned by 169 participants (95.5%). Due to administration error, end-of-day check-in questionnaires were not provided to 4 participants (2.3%). As such, total N's for analyses range from 162 to 176. Two-way ANOVAs revealed that there were no differences in rates of lab session, monitoring booklet or follow-up completion among the six experimental conditions, *F*'s (2, 169) < 2.01, *p*'s > .14.

The average age of the 176 participants was 41.5 years (*SD* = 13.4). The majority of the sample was male (64.8%), Caucasian (77.8%), and employed (51.2%). Most participants had completed at least some post-secondary education (67.0%). Participants were smoking an average of 16.5 cigarettes per day (*SD* = 6.05), for an average of 23.0 years (*SD* = 13.1). Mean on the Cigarette Dependence Scale (Etter, Le Houezec, Huguelet, & Etter, 2009) was 48.55 (*SD* = 6.89), which is similar to clients seen in smoking cessation clinics (*M* = 47.7, *SD* = 10.2) and slightly higher than smokers in the general population (*M* = 36.9, *SD* = 12.3; Etter, Le Houezec, Huguelet, & Etter, 2009). Participants had made an average of 5.7 serious attempts to quit smoking in the past, with their longest previous quit attempt lasting a median of 2 months (range = < 1 day – 2.5 years).

[2] Eleven individuals did not pass the breathalyzer test. When questioned about this, most people indicated that this was likely because they had either reduced their smoking during the last day or two or because they tended to smoke irregularly (e.g., heavily at social outings, lightly during the rest of the week).

Figure 2. Participation flow-chart



2.3 Measures

2.3.1 Appraisals of Craving Questionnaire (ACQ)/Catastrophic Appraisals Index (CAI)

The ACQ (Nosen & Woody, 2009) assesses how individuals interpret the occurrence of nicotine craving-related thoughts, images or impulses, with an emphasis on the types of appraisals researchers have identified to be problematic in studies of obsessions (OCCWG; 1997, 2001, 2003). Respondents are provided with a definition of craving-related cognitions and are asked to provide examples of two smoking-related thoughts, images or impulses they have recently experienced. Respondents then rate their level of belief (0 – 100%) in each of 26 interpretations with reference to their own smoking-related thoughts. Appraisals include beliefs that craving-related thoughts are personally significant (e.g., “These thoughts reveal something

important about me"), are directly tied to the success of one's attempt to quit smoking (e.g., "Having this unwanted thought means I will act on it") or need to be controlled (e.g., "It is important for me to cancel out or block the craving-related thoughts"). Seventeen of these items are averaged to create a total ACQ score (ranging from 0 to 100). The remaining 9 items represent infrequently endorsed, more extreme interpretations of craving-related thoughts (e.g., "this thought means I'm going to be punished") and are first dichotomized (any degree of endorsement vs. none), then summed to form the Catastrophic Appraisals Index (CAI; ranging from 0 to 9). The ACQ and CAI have demonstrated acceptable internal consistency, convergence with measures of obsessional appraisals and discrimination from depression (Nosen & Woody, 2009). The ACQ was completed at both lab sessions to provide a check for the psychoeducation manipulation. It was also used as a dependent variable in testing the effects of craving severity on metacognitive beliefs and in correlational analyses involving appraisals.

2.3.2 Metacognition Questionnaire (MCQ)

The MCQ (Wells & Cartwright-Hatton, 2004) is a 30-item measure assessing individual differences in the general metacognitive beliefs, judgments and monitoring tendencies featured in Well's S-REF model. It is not specific to smoking-related thoughts. The five subscales measure: (1) positive beliefs about worry (e.g., "worrying helps me cope"); (2) negative beliefs about worry concerning uncontrollability and danger (e.g., "when I start worrying I cannot stop"); (3) beliefs about cognitive confidence (e.g., "my memory can mislead me at times"); (4) beliefs about the need to control thoughts (e.g., "not being able to control my thoughts is a sign of weakness"); and (5) cognitive self-consciousness (e.g., "I pay close attention to the way my mind works"). The MCQ possesses good internal consistency, test-retest reliability, and convergent and predictive validity (Sica, Steketee, Ghisi, Chiri, & Franceschini, 2007; Spada, Mohiyeddini, & Wells, 2008; Wells & Cartwright-Hatton, 2004). The MCQ supplements the ACQ as a dependent variable in testing the effects of craving severity on metacognitive beliefs and in

correlational analyses involving appraisals.

2.3.3 Ruminative Response Scale – Brief Version (RRS)

The RRS (Nolen-Hoeksema & Morrow, 1991; Treynor, Gonzalez, & Nolen-Hoeksema, 2003) includes 22 items assessing the extent to which people respond to sadness or depressed mood by focusing on self, symptoms, and the causes and consequences of their mood. Items are rated on a 4-point Likert-type scale (ranging from 1 = almost never to 4 = almost always), with higher scores indicating greater ruminative tendencies. The RRS has demonstrated good internal consistency and temporal stability (Nolen-Hoeksema & Davis, 1999; Nolen-Hoeksema, Morrow, & Fredrickson, 1993), as well as acceptable convergent and predictive validity (Butler & Nolen-Hoeksema, 1994; Nolen-Hoeksema & Morrow, 1991). The RRS contains two subscales that assess brooding and reflective pondering; both show good internal consistency and test–retest reliability (Treynor et al., 2003). The RRS was completed during both lab sessions to facilitate assessment of the effects of smoking cessation and metacognitive psychoeducation on rumination. Only the brooding subscale (assessing the construct of maladaptive rumination) was used in analyses.

2.3.4 White Bear Suppression Inventory – Smoking (WBSI-S)

The WBSI (Wegner & Zanakos, 1994) is a 15-item self-report questionnaire that measures individuals' general tendency to suppress intrusive thoughts. Items are answered on a five-point Likert-type scale; scores are obtained by summing across all items, with higher scores indicating stronger tendencies to suppress unwanted intrusive thoughts. The WBSI has demonstrated adequate internal consistency and test-retest reliability (Muris, Merckelbach, & Horselenberg, 1996). However, as discussed, researchers have recently found that this measure contains two subscales, only one of which assesses suppression (Höping & de Jong-Meyer, 2003; Rassin, 2003). Use of the full scale, which includes a factor reflecting problems with intrusive thoughts, may artificially inflate apparent relationships with psychopathology (Höping & de Jong-Meyer, 2003; Rassin, 2003). Further, this measure asks about general

avoidance of thoughts, not specific avoidance of smoking-related thoughts; this may be responsible for some of the confusion within the thought suppression literature. As such, for the purposes of the current study, the WBSI was adapted to assess specific suppression of smoking-related thoughts during the between-session monitoring (e.g., item #1, "There are things I prefer not to think about" was changed to "I preferred not to think about smoking"). Only the "suppression" subscale items as identified by (Höping & de Jong-Meyer, 2003) was used in analyses. The WBSI-S was completed during the second lab session to facilitate assessment of the effects of smoking cessation and metacognitive psychoeducation on thought suppression. It was not completed during the first session to limit participant reactivity.

2.3.5 Thought Control Questionnaire (TCQ)

The TCQ (Wells & Davies, 1994) is a 30-item self-report measure designed to assess use of five strategies of controlling unwanted intrusive thoughts: distraction, punishment, reappraisal, social control, and worry. While this measure typically assesses *general* use of these strategies in response to any unwanted/unpleasant thought, participants completed this measure with reference to controlling smoking and craving-related thoughts over the between-session monitoring. Minor wording changes to the instructions and items (i.e., putting verbs in past tense) were made accordingly. Factor analyses suggest that the punishment and worry subscales seem to represent dysfunctional control strategies, while the social control, distraction and reappraisal strategies represent more functional strategies (McKay & Greisberg, 2002). Each subscale consists of six items rated on a four-point Likert-type scale (from 1 = "never" to 4 = "almost always"). The TCQ has demonstrated good internal consistency, test-retest reliability and convergent validity (Wells & Davies, 1994). The TCQ was completed during the second lab session to provide descriptive information on how people responded to cravings in supplement to the RRS and WBSI-S.

2.3.6 Anxiety Sensitivity Index-Revised (ASI-R)

The ASI-R (Taylor et al., 2007) is an 16-item measure in which respondents indicate the

degree to which they are concerned about possible cognitive, physical and social consequences of anxiety symptoms on a 5-point Likert-type scale ranging from 0 (very little) to 4 (very much). The ASI-R has good internal consistency and excellent convergent validity with other anxiety-related measures in non-clinical samples (Deacon, Abramowitz, Woods, & Tolin, 2003). The ASI-R was completed during the first and second lab sessions to facilitate assessment of the effects of smoking cessation and metacognitive psychoeducation on anxiety sensitivity, a potentially relevant covariate.

2.3.7 Depression Anxiety and Stress Scales (DASS)

The 21-item form of the DASS (Lovibond & Lovibond, 1995) is designed to assess depression, anxiety and stress as described by the tripartite model of affect (Clark & Watson, 1991). The DASS short-form scales show excellent internal consistency and temporal stability, and strong convergence with other widely used measures of anxiety and depression in both clinical and non-clinical populations (Antony, Bieling, Cox, Enns, & Swinson, 1998; Brown, Chorpita, Korotitsch, & Barlow, 1997; Crawford & Henry, 2003; Norton, 2007). The DASS discriminates reasonably well between features of depression, anxious arousal and general psychological tension and stress, and between depressed and anxious clinical groups (Antony et al., 1998; Brown et al., 1997; Crawford & Henry, 2003). The DASS was completed during both lab sessions to facilitate assessment of the effects of smoking cessation and metacognitive psychoeducation on symptoms of depression, anxiety, and general stress. As the depression, anxiety and stress subscales are highly correlated (*r's* >.7), only the total scale score was used in analyses.

2.3.8 Questionnaire of Smoking Urges-Brief (QSU-B)

The QSU-B (Cox, Tiffany, & Christen, 2001) assesses two aspects of craving severity: "a desire and intention to smoke with smoking perceived as rewarding," and "an anticipation of relief from negative affect with an urgent desire to smoke". Participants rate their agreement with each of the 10 items on a Likert-type scale ranging from 1 (strongly disagree) to 7 (strongly

agree). Subscales are created by averaging relevant items. This measure has demonstrated acceptable internal consistency, test-retest reliability and construct validity (Cappelleri et al., 2007). The QSU-B was completed at both lab sessions to serve as a dependent variable in testing the effects of metacognitive beliefs on craving severity.

2.3.9 Minnesota Nicotine Withdrawal Scale (MNWS)

The MNWS (Hughes & Hatsukami, 1986) measures the experience of eight common nicotine withdrawal symptoms, including: irritability/anger, anxiety/tension, difficulty concentrating, restlessness, increased appetite or weight gain, depressed or sad mood, impatience, and craving. Participants rate the intensity of symptoms on an ordinal scale ranging from 0 to 4 (Not present, Mild, Moderate, and Severe). A total withdrawal score is calculated as the average of the first seven items (i.e., excluding "Desire to smoke"; Hughes & Hatsukami, 1998). The scale is frequently used to quantify signs and symptoms of withdrawal from cigarettes and has demonstrated good internal consistency and predictive validity (Hughes & Hatsukami, 1986; Toll, O'Malley, McKee, Salovey, & Krishnan-Sarin, 2007; Weinberger et al., 2007). The MNWS was completed during the second lab session to facilitate assessment of the effects of smoking cessation and metacognitive psychoeducation on symptoms of subjective nicotine withdrawal.

2.3.10 Cigarette Dependence Scale (CDS)

The CDS (Etter, Le Houezec, & Perneger, 2003) assesses nicotine dependence on a 12-item scale. The CDS has demonstrated good internal consistency, retest reliability, convergent and predictive validity (Etter, 2008; Etter et al., 2003). The CDS was completed during the first lab session to examine how pre-cessation level of nicotine dependence affects craving severity and smoking behaviour (i.e, for use as a potential covariate or moderator).

2.3.11 Demographics and Smoking History

Demographics, including age, gender, ethnic background, employment status, occupation and education, were assessed during the first lab session. Smoking history was assessed with

questions on pre-cessation smoking habits (e.g., duration and quantity of smoking, use of alternative tobacco products) and quit attempts (e.g., number and duration of attempts). Cessation motivation was assessed with two items adapted from previous studies (Hall, Havassy, & Wasserman, 1991; Marlatt, Curry, & Gordon, 1988), including a 6-point measure of abstinence goal (total abstinence, never use again; total abstinence, but realize a slip is possible; occasional use when urges strongly felt; temporary abstinence; controlled use; and no goal) and desire to quit measured on a 10-point scale (strong desire = 10). During the second lab session, participants reported on use of cigarettes, alternative tobacco products, nicotine replacement aids during the preceding three days, and current cessation motivation.

2.3.12 Brief Michigan Alcoholism Screening Test (Brief MAST)

The brief MAST (Pokorny et al., 1972) is a widely used 10-item measure designed to identify past-year alcohol-use problems. Items (e.g., “Do you feel you are a normal drinker?”) are scored by allocating between 2 and 5 points to each “yes” answer; total scores above 5 are considered clinically significant and indicative of alcohol abuse or dependence. The brief MAST has good construct validity and test-retest reliability as a screening instrument for alcoholism in community samples (Crowe, Kramer, Hesselbrock, Manos, & Bucholz, 1997). Participants completed this measure with reference to the previous year as a part of the telephone-screening interview; individuals scoring above 5 were excluded from the study.

2.3.13 Drug Abuse Screening Test (DAST-10)

The DAST-10 (Skinner, 1982) is a brief 10-item version of the original 28-item DAST designed to identify drug-use related problems in the previous year. Items (e.g., “Have you used drugs other than those required for medical reasons?”) are scored by allocating 1 point to each “yes” answer; total scores of 3 or above are considered clinically significant and indicative of substance dependence. It has demonstrated good internal consistency, temporal stability and construct validity (Cocco & Carey, 1998; Maisto et al., 2000). Participants completed this measure as a part of the telephone-screening interview; individuals scoring above 2 were

excluded from the study.

2.3.14 Ecological Momentary Assessment (EMA)

Researchers have recommended use of real-time, real-world assessments of subjective phenomena, rather than daily or weekly retrospective reports, as momentary, episodic urges to smoke may be more strongly associated with relapse than overall or average craving levels (Shiffman, Engberg, et al., 1997; Shiffman, Hickcox, et al., 1996). Indeed, mounting evidence suggests that people are relatively poor at recalling frequent, irregular and ordinary experiences like thoughts, craving, mood state and smoking (Bradburn, Rips, & Shevell, 1987; Hammersley, 1994; Schwarz, 2007; Shiffman, Hufford, Hickcox, Paty, & et al., 1997). Subjective ratings of intensity (e.g., strength of craving or feelings) show considerable memory bias, even after very short delay (Robinson & Clore, 2002; Schwarz, 2007).

Accordingly, participants completed in vivo monitoring of craving between the two lab sessions. Participants were provided with a pager and a pocket-sized coil-bound pad of paper with pre-printed questions; a small pen was attached to the paper pad. Questions asked participants to indicate the time and date. Participants also completed a single-item Visual Analogue Scale (VAS) assessment of smoking urge ("How strong is your urge to smoke?") answered on a 50mm scale anchored by "not at all" on the left, and "extremely" on the right. This wording is frequently used in studies assessing nicotine cravings via VAS (Dols, van den Hout, Kindt, & Willems, 2002; Dols, Willems, van den Hout, & Bittoun, 2000; Lee et al., 2003). There appears to be no significant loss of precision or accuracy in VAS assessments considerably shorter than the traditional 10 cm lines (Kreindler, Levitt, Woolridge, & Lumsden, 2003). Participants also indicated how much they had smoked since the last form completion. Each form took approximately 1 minute to complete.

2.4 Apparatus

2.4.1 Bedfont Scientific Ltd piCO+ Smokerlyzer

The *Bedfont Scientific Ltd. piCO+™ Smokerlyzer®* carbon monoxide breathalyzer is a

non-invasive, hand-held indicator of smoking status. These devices are valid and reliable indicators of smoking status, with cut-off levels of 8ppm used to identify recent (i.e., past-day) smoking behaviour (Becoña & Vásquez, 1998; Benowitz et al., 2002; Javors, Hatch, & Lamb, 2005). This monitor was used at the lab sessions to verify past day smoking and encourage accurate self-reporting of more distal smoking behaviour.

2.4.2 Pagers

Participants were provided with a Rogers Sun Telecom Titan III alphanumeric pager that signaled them to complete in vivo assessments of cravings. Participants were instructed to keep the pager set to receive an auditory plus vibration alert unless the sound of a pager beep would be inappropriate (e.g., during a meeting or movie); in this case they could turn the pager to vibration only. Pages were scheduled and sent using NotePager Pro® computer software. Timing of the prompts was random within eight equally spaced segments of the waking hours specified by the participant. If a page was not read, the pager prompted the participant with a brief auditory signal every few minutes. A reference page was included in each questionnaire booklet to provide researcher contact information and instructions on pager use (e.g., how to turn pager to vibrate only) and what to do in the event of a mishap (e.g., if pager or question booklet left at home).

2.5 Procedure

All procedures were implemented by undergraduate research assistants blind to study hypotheses. They were trained and supervised by the primary study author.

2.5.1 Eligibility Screening

Study eligibility was assessed over the phone. All eligible participants were asked to select a date to quit smoking within the next two weeks and were then randomly assigned to a cessation condition. Individuals in the cessation attempt condition were asked to attend their first session at our UBC research lab on the day immediately before quitting; they attended the second lab session 96 hours later (i.e., on the fourth day of their quit attempt). Individuals in the

anticipated cessation condition were asked to attend their first lab session 8 days before their anticipated quit date and the second 96 hours later (i.e., four days prior to their quit date).

2.5.2 Session 1

In the first session, participants completed an informed consent form, followed by a biochemical confirmation of smoking status using an electronic breath monitor testing for expired carbon monoxide (Smokerlyzer® monitor). Individuals who did not appear to smoke regularly based on CO monitor results (CO levels < 8 ppm) did not continue with participation. Following this, participants completed several questionnaires presented in one of three counterbalanced orders. These questionnaires assessed demographics and smoking history (including nicotine dependence; CDS), metacognition (ACQ; MCQ), rumination (RRS), symptoms of depression, anxiety and stress (DASS) and current craving severity (QSU-B). Questionnaires were presented online, facilitated by a Web-based survey development and hosting service (SurveyMonkey.com). Questionnaire completion time was approximately 30 minutes. All participants were provided an opportunity to take a quick break following these questionnaires.

Following this, participants were randomly assigned to one of the three experimental conditions. During this portion of the study, participants received psychoeducation about metacognitive responses to cravings (metacognition condition), received general information about smoking and cessation methods (education control) or completed some additional questionnaires (no education control). Psychoeducation was presented on a computer via Microsoft Powerpoint. Slides were overlaid with an audio track that verbalized the written educational points (spoken by a professional voice actor). To ensure comprehension, participants were signaled to stop after key presentation points (every 3-5 minutes) in order to reflect and apply the information to their own lives. At these points, structured questions appeared on the screen (e.g., “has it ever felt as though cravings show you are weak?” or “how might your cultural background relate to smoking?”). These questions were re-printed on a

sheet of paper provided to participants; participants recorded their answers on the lines below. At each stop point, a research assistant briefly reviewed participants' answers with them to confirm comprehension and provide assistance or correction as needed.

2.5.2.1 Psychoeducation Manipulation

In the *metacognition* condition, this presentation focused on the nature of cravings and thoughts about smoking, with the goal of reducing maladaptive appraisals and responses to craving-related thoughts, images and impulses. Participants were informed that cravings are normative, transient phenomena that do not mean anything personally significant about one's character. For example, participants were told that thoughts about smoking do not mean the individual is abnormal, being punished, going crazy, weak-willed, emotionally unstable, etc. Structured questions asked participants to generate personal examples of craving-related thoughts, potential over-interpretations of cravings, associated emotional responses, and more helpful ways of thinking as a means of Socratically challenging any problematic metacognitive beliefs. Attention was also given to the idea that it is impossible to fully control cravings and that one should not be upset or discouraged by failures to do so. The normality of failures to perfectly control both general and smoking-specific thoughts was reinforced through brief participatory exercises (e.g., asking participants to try to think about anything *except* for smoking for two whole minutes and observing the outcome). Participants were informed that people successfully quit smoking despite experiencing frequent and bothersome thoughts about smoking and craving. These psychoeducational techniques are common to cognitive behavioural therapeutic approaches and were derived from treatments of obsessions targeting problematic appraisals of unwanted thoughts (Rachman, 2003). Participants were encouraged to respond to cravings by simply noticing them, focusing on physiological sensations, accepting cravings and passively allowing them to wax and wane on their own, rather than actively trying to fight them. This is similar to the "urge surfing" technique used in mindfulness-based approaches to substance use relapse prevention (Bowen et al., 2009; Witkiewitz & Marlatt,

2004; Witkiewitz, Marlatt, & Walker, 2005). Participants were provided an opportunity to practice this technique twice in the presence of smoking cues (pictures of smoking on the slides).

In the *non-metacognitive* control condition, discussion focused on smoking risk factors and common cessation methods, with the goal of matching the metacognitive discussion's level of information, relevance to smoking cessation, experimenter attention, and participant involvement. Participants received basic descriptive information on various risk factors for smoking (e.g., age, gender, culture) as well as smoking cessation techniques implemented at both the population-level (e.g., public smoking bans, public service announcements, quit and win contests), and individual level (e.g., hypnosis, acupuncture, nicotine replacement aids). Participants were encouraged to think about and understand their personal risk factors for smoking. Questions asked participants to reflect on their experiences with the presented cessation techniques (e.g., whether they have seen/used the technique, how it has influenced their smoking). Information content and questions did not address cravings or thoughts about smoking. To ensure that the metacognitive condition did not simply show effects due to the introduction of coping techniques, participants in the psychoeducation control condition were also instructed in problem solving and strategies for building social support. This condition was not expected to produce any observable changes in measures of metacognition. However, talking to participants about cessation and encouraging use of effective coping were important to control for as they may incidentally potentially boost cessation self-efficacy and perhaps even success.

As a comprehension check following the psychoeducation, participants were asked to write a few sentences outlining what they took to be the main point of the discussion. Correction or further discussion to ensure participants understood the key presentation points was provided as needed. To check group equivalence on non-specific presentation qualities, participants also completed visual analogue scale ratings of responses to the intervention (i.e., how engaging, interesting, novel and relevant they found the discussion). In total, the psychoeducational

presentations took approximately 1 to 1.5 hours, depending upon the pace with which the participant completed the questions during the presentation.

The *no psychoeducation* control condition was intended as a second comparison group that does not provide non-specific treatment effects. In this condition, participants did not receive any supplementary psychoeducation. Instead, participants spent the equivalent amount of time completing some filler questionnaires, including a few measures designed to facilitate examination of the convergent and discriminant validity of the Appraisals of Craving Questionnaire. These measures included the Acceptance and Action Questionnaire (AAQ; Hayes et al., 2004), Difficulties with Emotion Regulation Questionnaire (DERS; Gratz & Roemer, 2008) and Distress Tolerance Scale (DTS; Simon & Gaher, 2005).

2.5.3 Between-Session Monitoring

Participants then received instruction in the in vivo, between-session measurement of cravings and smoking behaviour. Approximately 15 minutes were spent describing the procedures to participants, having them complete an example form and problem-solving potential difficulties with monitoring. Participants were encouraged to use their own cell phone as a signaling device instead of a pager when possible to ease participant burden and difficulties with novel technology. Even so, 72.7% opted to use a pager. Participants were instructed to temporarily turn the pager (or their cell-phone) to vibrate if they planned to be in a quiet location, to complete the form as soon as they remember (based on their current feelings) if they forgot to respond or missed a page and to immediately call the primary investigator's cell phone if they forget either the pager or monitoring paper at home. Participants were asked to identify their projected hours of waking and sleeping over the next three days; pagers were programmed to signal at eight random intervals within this time frame. To minimize initial reactivity, three pages were also sent to participants in the hours following the first lab session (data not included in analyses). To reduce inaccurate reporting, researchers instructed participants not to go back and complete missed forms. There was no penalty for uncompleted

forms and payment was not contingent on form completion.

Sixteen individuals (9.1%) reported technical problems with the pager (e.g., battery died, weren't receiving pages for some reason, couldn't figure out how to work pager). As an alternative to not completing any monitoring, three individuals were instructed to simply complete monitoring forms approximately every two hours (eight per day). Including these individuals, participants completed an average of 7.33, 6.77 and 6.63 entries on days 1, 2 and 3, respectively. Overall compliance rate was 89.0%. This rate is on par with (if not better than) rates seen in other studies employing short-term ecological momentary assessment involving smokers attempting to quit (Catley & Grobe, 2008; O'Connell et al., 1998; Rowan et al., 2007; Waters & Li, 2008).

2.5.4 Session 2

Participants returned to the lab four days after the first session. Upon arrival at the lab, smoking status was again assessed with the CO breath monitor. Participants then completed measures assessing metacognitive responses to cravings (ACQ-manipulation check; MCQ; WBSI; TCQ; RRS), craving severity (QSU-B), symptoms of nicotine withdrawal (MNWS), negative affect (DASS) and anxiety sensitivity (ASI-R). Questionnaires were again completed online (facilitated by Surveymonkey.com) and presented in one of three counterbalanced orders.

At the end of this session, all participants were paid for their participation and partially debriefed (specific study hypotheses were not mentioned as not to influence behaviour during the subsequent one-month follow-up period). All participants also received a 48-page Health Canada booklet outlining basic tips and information about smoking cessation. For example, all participants learned how the body benefits from quitting smoking in the minutes, days and months after cessation begins; booklets encouraged participants to take things one day at a time and to reward themselves for their successes. The booklet provided is available to participants free of charge through the Health Canada website and through a variety of other

online and community sources. Thus, this information is consistent with what participants would normally come across through their own smoking cessation queries. This second session took approximately 45 minutes to complete.

2.5.5 Follow-Up Survey

In order to examine moderately extended cessation outcomes, participants also completed a brief follow-up survey via email or phone one month after their intended cessation date. Participants reported on current number of cigarettes smoked per day and duration of quit attempt.

2.5.6 Pilot Testing

Qualitative, focus group style pilot testing was conducted prior to data collection. This testing involved 30 individuals recruited from the community. Participants who indicated that they currently smoke, have smoked an average of 10 or more cigarettes per day during the past year, were between the ages of 19-65 and were fluent in English had the opportunity to sign up for the study; only a portion were asked to actually quit smoking. During the pilot testing, participants were run through the experiment as described, but feedback and open discussion about various aspects of the methodology were sought throughout (e.g., questionnaire fatigue, clarity of psychoeducation, ease of pager monitoring). Participants also completed the ACQ as a check on the metacognition manipulation. Piloting of procedures indicated that completing eight monitoring forms per day was not overly burdensome for most participants and that the psychoeducational presentations produced change in metacognitive beliefs (as observed via comparatively lower post-presentation ACQ scores in the metacognition condition). Pilot participants are not included in statistical tests of study hypotheses.

2.6 Data Cleaning

Prior to analysis, all control and study variables were first examined through SPSS programs for missing values, outliers, and fit with the assumptions of multivariate analysis. Missing data were handled on a case-by-case basis, depending on the type of data missing and

the analyses affected. Missing questionnaire items were replaced with values predicted from a linear regression equation formed from the remaining scale items (only when missing less than 10% of scale items). This procedure affected a total of 63 individual questionnaire items, all from measures completed on paper (because online survey did not permit missing responses), distributed across 40 different questionnaires from 11 people in all six conditions. Cases missing data on constructs measured with single items (e.g., cigarettes smoked per day, CO data) or missing more than 10% of items on a questionnaire were excluded for relevant analyses. Missing data was primarily from participants who did not complete the end-of-day (n = 4) or second lab session (n = 5) questionnaires.

Forty-two within-group univariate outliers were detected within the whole dataset, distributed across all six conditions. These values were winsorized (i.e., replaced with a value adjacent to the next value) prior to analysis. Log transformations were applied to several variables to improve outliers and normality, including longest time abstinent from smoking, number cigarettes smoked per day, all DASS subscales (T1 and T2), two MCQ subscales (pos, neg; T1 and T2) and two TCQ subscales (punishment and worry). No multivariate outliers were detected based on Malahnobis distance and bivariate scatter plots between variables of primary interest appeared linear and homoscedastic.

Chapter 3: ACQ and CAI Measure Development

3.1 Introduction

While preliminary evidence suggests that metacognitive beliefs are relevant to understanding substance use disorders (Spada & Wells, 2005; Spada, Zandvoort, et al., 2007), measurement of these constructs is still in the developmental stage. Several researchers (Hoyer et al., 2007; Spada, Nikčević, et al., 2007; Spada & Wells, 2005, 2006; Spada, Zandvoort, et al., 2007) have assessed metacognition among smokers and alcohol users with the Metacognition Questionnaire (MCQ) or adaptations thereof. This measure was originally developed to help understand Generalized Anxiety Disorder and assesses metacognitive beliefs pertinent to Self-Regulatory Executive Function theory (S-REF: Wells & Matthews, 1994), including unfounded beliefs about both the benefits and dangers of worrying, lack of confidence in one's own attention and memory ("cognitive competence"), increased tendency to monitor and attend to one's thoughts, and beliefs that thoughts need to be controlled (Wells, 2000). Metacognition measured with the MCQ correlates with alcohol use (Spada & Wells, 2005; Spada, Zandvoort, et al., 2007) and also partially mediates the relationship between negative emotions and level of nicotine dependence (Spada, Nikčević, et al., 2007).

Researchers of obsessions highlight several related types of appraisals believed to be important in the development of frequent and distressing intrusive thoughts, including overestimation of the personal significance of the thought (e.g., *this thought means I am a bad person)*, "thought-action fusion" or flawed beliefs about the perceived consequences of having an unwanted intrusive thought (e.g., *having this thought means I will undoubtedly act on it)*, and an unrealistic desire to maintain perfect thought control (e.g., *I must control this thought;* (Obsessive Compulsive Cognitions Working Group (OCCWG), 1997, 2001, 2003). Nosen and Woody (2009) derived the Appraisals of Craving Questionnaire (ACQ) and Catastrophic Appraisals Index (CAI) from commonly used measures of obsessions to investigate the applicability of these metacognitive beliefs among people attempting to quit smoking.

The ACQ assesses how individuals interpret the occurrence of nicotine craving-related thoughts, images or impulses, with an emphasis on the types of appraisals researchers have identified to be problematic in studies of obsessions (OCCWG; 1997, 2001, 2003). Respondents are provided with a definition of craving-related cognition and are asked to provide examples of two smoking-related thoughts, images or impulses they have recently experienced. Respondents then rate their level of belief (0 – 100%) in each of 26 interpretations with reference to their own smoking-related thoughts. Appraisals include beliefs that craving-related thoughts are personally significant (e.g., "These thoughts reveal something important about me"), are directly tied to the success of one's attempt to quit smoking (e.g., "Having this unwanted thought means I will act on it") or need to be controlled (e.g., "It is important for me to cancel out or block the craving-related thoughts"). Seventeen of these items are averaged to create a total ACQ score (ranging from 0 to 100). The remaining 9 items represent infrequently endorsed, more extreme interpretations of craving-related thoughts (e.g., "this thought means I'm going to be punished") and are first dichotomized (any degree of endorsement vs. none), then summed to form the CAI (ranging from 0 to 9). The ACQ and CAI have demonstrated acceptable internal consistency, convergence with measures of obsessional appraisals and discrimination from depression (Nosen & Woody, 2009).

The ACQ and CAI have not been used in any other studies, however, and the present work uses an arguably different population (online, recently quit smokers in Nosen & Woody, 2009 vs. local, biochemically verified current smokers motivated to set a cessation date and participate in a much more intensive study). As such, the validity and appropriateness of these measures in this context is not immediately evident. The relationship between the ACQ, CAI and MCQ is also unknown.

Fortunately, the present study provides opportunity to examine several psychometric properties to help further develop and refine the ACQ and CAI. As such, the following sections describe an examination of ACQ/CAI test-retest reliability, scale refinement, factor structure,

internal consistency and convergence with other measures of metacognition and tolerance of distressing internal experiences. The ACQ and CAI are anticipated to correlate positively with several subscales of the MCQ, particularly the subscales assessing positive beliefs (e.g., "worrying helps me cope"), negative beliefs (e.g., "my worrying could make me go mad") and need for control (e.g., "I should be in control of my thoughts all the time"), as these metacognitive beliefs have previously been associated with nicotine dependence (Nikčević and Spada, 2008; Spada, Nikčević et al. 2007). As the ACQ and CAI are also theoretically related to difficulties tolerating distress and uncomfortable internal sensations, negative correlations with the Distress Tolerance Scale (DTS, high scores reflect greater tolerance; Simon & Gaher, 2005), and positive correlations with the Acceptance and Action Questionnaire (AAQ; Hayes et al., 2004) and nonacceptance subscale of the Difficulties with Emotion Regulation Questionnaire (DERS; Gratz & Roemer, 2008) would also support convergent validity. Discriminant validity would be supported by relatively lower correlations with arguably less relevant MCQ subscales, including cognitive self-consciousness (e.g., "I pay attention to how my mind works") and cognitive confidence (e.g., "I do not trust my memory").

3.2 Method

3.2.1 Participants

Participants for the majority of analyses were the full sample of 176 English-speaking adult smokers. A subset of analyses examining convergent and discriminant validity used only the participants assigned to the no psychoeducation control condition (n = 58). See Section 2.2 for full sample details.

3.2.2 Measures

3.2.2.1 Metacognitive Appraisals (ACQ and CAI)

The ACQ and CAI (Nosen & Woody, 2009) assess how individuals interpret the occurrence of nicotine craving-related thoughts, images or impulses. See Section 2.3.1 for full measure details.

3.2.2.2 Metacognition Questionnaire (MCQ)

The MCQ (Wells & Cartwright-Hatton, 2004) is a 30-item measure assessing five types of metacognitive beliefs, judgments and monitoring tendencies featured in Well's S-REF model. See Section 2.3.2 for details on this measure.

3.2.2.3 Acceptance and Action Questionnaire (AAQ)

The AAQ (Hayes et al., 2004) assesses discomfort with and attempts to avoid unpleasant thoughts, emotions and other internal sensations (i.e., experiential avoidance). Higher scores reflect greater experiential avoidance. The AAQ has good internal consistency, convergent and discriminant validity (Hayes et al., 2004).

3.2.2.4 Difficulties with Emotion Regulation (DERS)

The DERS (Gratz & Roemer, 2008) is a 36-item questionnaire assessing aspects of emotion dysregulation. Only the 6-item nonacceptance of emotional response subscale was used in the current analyses. Higher scores reflect greater nonacceptance. The scale shows adequate internal consistency and convergent validity (Gratz & Roemer, 2008; Gratz, Rosenthal, Tull, Lejuez, & Gunderson, 2006).

3.2.2.5 Distress Tolerance Scale (DTS)

The DTS (Simons & Gaher, 2005) is a 15-item measure in which respondents indicate on a 5-point Likert-type scale (1 = strongly agree to 5 = strongly disagree) the extent to which they believe they can withstand upsetting emotional experiences. Higher scores reflect greater distress tolerance. It has a stable factor structure and shows good test-retest reliability and convergent validity (Leyro, Bernstein, Vujanovic, McLeish, & Zvolensky, 2010; Simons & Gaher, 2005).

3.2.3 Procedures

Measures were administered as a part of the larger study protocol (see Section 2 for details). All participants (*N* = 176) completed the ACQ/CAI and MCQ three times: twice at T1 (once prior to psychoeducation, once after) and once at T2 (four days later, following ecological

momentary assessment). Participants in the condition assigned to the no psychoeducation control group (*N* = 58) completed several additional measures in lieu of the psychoeducation during the first lab session, these measures included the AAQ, DERS and DTS.

3.2.4 Analytic Overview

The goal of the following analyses was to investigate the psychometric properties of the ACQ/CAI to facilitate further measure refinement. Internal consistency and factor structure of the ACQ and CAI, scored according to Nosen and Woody (2009), were first investigated using the full sample Time 1 data (i.e., prior to both psychoeducation and smoking cessation manipulations; *N* = 177). Test-retest reliability was also examined, but only within the no psychoeducation control condition (as minimal change was expected over time). Based on these analyses, several poorly performing items were removed. Following measure refinement, internal consistency, test-retest reliability and convergence with the MCQ (in the full sample) and the AAQ, DERS and DTS (no psychoeducation control group participants only) were re-examined.

3.3 Results

3.3.1 Original Scoring

Cronbach's alpha was .91 for both the ACQ and CAI, indicating excellent internal consistency. However, test-retest reliability coefficients were less optimal. For the ACQ, time 1 scores correlated at .59 and .54 with the same measure completed approximately 1 hour (end of same lab session) and 4 days later (second lab session), respectively. For the CAI, Spearman's rho coefficients were .71 for both 1-hour (T1 vs end of day) and 4-day (T1 vs T2) test-retest reliability. As this implies that considerable error may be present, particularly on the ACQ, item psychometrics were re-examined for inclusion suitability.

In the original scale development, CAI items were separated out due to infrequent endorsement. In the current sample, eight of the nine CAI items had a similar pattern of low endorsement, with 40.1% to 65.5% of participants denying any belief in these items. One CAI

item, “this thought means that what I’m doing will be ruined” had slightly more frequent endorsement (32.2% “did not believe this idea at all”), although endorsement declined over time in Condition 3 (46.6% disbelief at end of time 1, 44.8% at time 2). One ACQ item, “because I can’t control this thought, I’m a weak person” had less frequent endorsement (37.9% “did not believe this idea at all”) that was maintained over time in Condition 3 (39.7% disbelief at end of time 1, 44.8% at time 2). As such, the one ACQ item was dichotomized and added to the CAI along with the original nine items.

Consideration was given to combining the CAI and ACQ into a single scale, but when CAI items were included in a factor analysis alongside ACQ items, analysis yielded a multi-dimensional factor structure that was difficult to interpret and that varied depending on time of administration. This was interpreted as a function of including the highly skewed items in the analysis, which can produce unstable factor structures (Tabachnick & Fidell, 2007). Further, combining into a single scale would limit ability to compare results with previous work using the ACQ/CAI. As such, items were included in a separate scale, as in Nosen and Woody (2009).

Table 1 displays test-retest reliability of individual ACQ/CAI items. Three items had particularly poor (< .10) 1-day or 4-day reliability. In hindsight, it is possible that the wording of these three items created inconsistency in interpretation: “If I don’t control this thought, I am likely to start smoking again” – the “again” might confuse people who are continuing to smoke; “Thinking this thought could make it happen” and “This thought means that one day I may actually carry out some actions related to the thoughts” – both could potentially be interpreted in multiple ways depending on the thought in question. These items were subsequently removed from the measure.

Table 1

Test-Retest Reliability of Individual Items

Item	1-hour	4-day
Appraisal of Craving Questionnaire		
This thought means that my attempts to quit smoking are destined to fail	.28	.22
The more I think about these things, the greater the risk they will come true.	.51	.42
If I don't control this thought, I am likely to start smoking again.	.20	***.07***
Having this unwanted thought means I will act on it.	.31	.28
I would be a better person if I gained more control over this thought	.56	.36
It is important for me to cancel out or block the thoughts	.31	.56
Quitting smoking would be much easier if I gained control over this thought	.37	.41
I should be able to rid my mind of this thought	.17	.16
Thinking this thought could make it happen	.11	***.01***
I must have control over this thought	.46	.42
These thoughts mean that I might lose control and act on the thought	.29	.11
I must regain control of this thought	.41	.49
I am irresponsible if I don't resist this unwanted thought	.19	.37
Because I can't control this thought, I am a weak person	.38	.28
I should not be thinking this kind of thing.	.41	.31
These thoughts mean that one day I may actually carry out some actions related to the thoughts	***.05***	.28
I feel responsible for these thoughts	.38	.36
Catastrophic Appraisals Index		
Other people would think that I am crazy or mentally unstable	.47	.33
Other people would condemn or criticize me if they knew about my thoughts	.59	.37
I've had this intrusive thought, what I'm doing will be ruined	.26	.37
Having this intrusive thought means that I could lose control of my mind	.50	.37
It is important for me to keep these thoughts secret from most or all of the people I know	.51	.42
These thoughts mean that I am really an impostor or a phony	.38	.19
Having this intrusive thought means I'm out of control	.47	.27
I will go crazy if I do not stop thinking these thoughts	.21	.39
If I don't control this thought, I'll be punished	.54	.42

Note: Analysis includes only individuals who did not receive any psychoeducation, n = 58.

3.3.2 ACQ Factor Analysis

An exploratory factor analysis was performed on the remaining 13 ACQ items (Time 1 measurement). This analysis was conducted through SPSS 17.0 using principal-axis extraction. The aim was to estimate the dimensionality of the final ACQ and to identify any additional items to exclude on the basis of poor factor loadings (<.40). Kaiser's Meyer Olkin measure of sampling adequacy was .91, suggesting that the analysis should yield reliable factors (Field, 2000). Bartlett's test of sphericity was also significant, $\chi^2(78) = 905.63$, $p < .01$, confirming the presence of a relationship between the items.

Two factors with eigenvalues greater than one were extracted, accounting for a cumulative 53.67% of the scale variance. Eigenvalues were 5.64 and 1.34, accounting for 43.35% and 10.31% of the variance in the ACQ respectively. Investigation of the scree plot confirmed a clear break between the 1st and 2nd components, and all items loaded (>.46) on the first factor. Analyses of subsequent administrations (at end of the first lab session and at time 2) yielded similar results and supported the use of the ACQ as a unidimensional scale. Item content, communalities and factor loadings are shown in Table 2.

Table 2

Principal Axis Factor Analysis of Appraisal of Craving Questionnaire (*N* = 176)

Item	Factor loading	Communality
Having this craving related thought means that my attempts to quit smoking are destined to fail.	0.46	0.21
The more I think about these things, the greater the risk they will come true.	0.61	0.38
Having this unwanted thought means I will act on it.	0.55	0.30
I would be a better person if I gained more control over this thought.	0.68	0.46
It is important for me to cancel out or block the craving related thoughts.	0.70	0.49
Quitting smoking would be much easier if I gained control over this thought.	0.75	0.56
I should be able to rid my mind of this thought.	0.54	0.29
Thinking this thought could make it happen.	0.77	0.60
I must have control over this thought.	0.69	0.48
I am irresponsible if I don't resist this unwanted thought.	0.79	0.63
I should not be thinking this kind of thing.	0.64	0.41
I must regain control of this thought.	0.71	0.50
I feel responsible for these thoughts.	0.57	0.33

3.3.3 Re-examining Reliability

Cronbach's alphas for the 10-item CAI and the 13-item ACQ at time 1 were .88 and .89, respectively. Test-retest reliability coefficients for the revised scales were marginally improved. For the ACQ, time 1 scores correlated at r = .64 and r = .59 with the same measure completed approximately 1 hour (end of same lab session) and 4 days later (second lab session), respectively. For the CAI, Spearman's rho coefficients were .73 for both 1-hour (T1 vs end of day) and 4-day (T1 vs T2) test-retest reliability.

3.3.4 Concurrent Validity

To investigate the concurrent validity of the ACQ and CAI, correlations with other measures of metacognitive beliefs were examined. In theory, appraisals of cravings as measured by the ACQ and CAI would be expected to correlate higher with overly meaningful interpretations of cognition (MCQ-positive beliefs about worry; MCQ-negative beliefs about uncontrollability/danger of worry), desire for cognitive control (MCQ-need for control) and discomfort with emotions and other internal sensations (AAQ, DERS- nonacceptance, DTS). Lower correlations would be expected with more general aspects of metacognition, such as confidence in memory (MCQ – cognitive confidence) and potentially attentiveness to thoughts (MCQ – cognitive self-consciousness). Bivariate correlations between the ACQ, CAI and the MCQ subscales (Time 1, full sample) and AAQ, DERS-nonacceptance subscale and DTS (Time 1, Condition 3 only) are presented in Table 3. ACQ scores correlated strongly with CAI scores at T1 (r = .61, p < .01).

Table 3

Concurrent Validity of ACQ and CAI

Measure	Appraisals of Craving Questionnaire	Catastrophic Appraisals Index
Metacognition Questionnaire (N = 176)		
Positive beliefs about worry	.33**	.42**
Negative beliefs about uncontrollability /danger of worry	.44**	.42**
Cognitive confidence	.15*	.20**
Need for control	.50**	.43**
Cognitive self-consciousness	.26**	.17*
Acceptance and Action Questionnaire (n = 58)	.32*	.30*
DERS – Nonacceptance (n = 58)	.35**	.43**
Distress Tolerance Scale (n = 58)	-.28*	-.38**

Note: DERS = Difficulties with Emotion Regulation Scale. * p < 05. **p < .01.

3.4 Summary

The original method of scoring the ACQ and CAI yielded strong internal consistency but only moderate test-retest reliability, particularly for the ACQ. Examination of individual items provided support for removing a few items from the ACQ based on infrequent endorsement and exceptionally poor test-retest reliability. The infrequently endorsed item was added to the CAI. Thus, the ACQ and CAI were altered to consist of 13 and 10 items, respectively.

The refined ACQ and CAI also had strong internal consistency. Test-retest reliability was somewhat improved, but still moderate given the brief retest interval. Generally, correlations with other measures provided adequate support for the convergent and discriminant validity of the ACQ and CAI. Specifically, moderate to large correlations existed between appraisals of cravings as measured by the ACQ and CAI and overly meaningful interpretations of cognition (MCQ-positive beliefs about worry; MCQ-negative beliefs about uncontrollability/danger of worry), desire for cognitive control (MCQ – need for control) and discomfort with emotions and other internal sensations (AAQ, DERS- nonacceptance, DTS). Small correlations were observed with more general aspects of metacognition, including confidence in memory (MCQ – cognitive confidence) and attentiveness to thoughts (MCQ – cognitive self-consciousness), which suggest modest discriminant validity. In sum, the ACQ/CAI demonstrates acceptable internal consistency and concurrent validity. Test-retest reliability is adequate, though not impressive.

Chapter 4: Correlational Relationships

4.1 Introduction

To review, metacognitive models suggest that while nearly everyone attempting to quit smoking experiences nicotine cravings in the form of smoking and craving-related thoughts, images and urges during cessation, the way people interpret or appraise cravings may be an important determinant of future cravings. Specifically, individuals who appraise their craving-related thoughts in negative, overly personal or catastrophic ways (i.e., as meaning that they are weak-willed, destined to fail, or out of control) are likely be more distressed by cravings. In turn, this theoretically elicits urges to smoke to relieve negative affect and encourages unhelpful coping responses like suppression and rumination. Due to the paradoxical effects of suppression, increased attentional focus on cravings, and further distress at failures to control thoughts, responses such as suppression and rumination are theorized to further exacerbate smoking-related thoughts and urges to smoke. Finally, reappearance of the craving strengthens and confirms appraisals of the importance of the thought, encouraging an escalating cycle of distress, maladaptive responses and cravings.

Previous research has provided some support for this model in relation to alcohol, methamphetamine and smoking. For example, in recently abstinent alcohol abusers, appraisals of alcohol-related intrusions as unpleasant (e.g., “this thought disturbs me”) and as uncontrollable and linked to action (e.g., “this thought is stronger than my will”; “this thought can really make me drink”) correlated with increased craving, greater tendencies to suppress alcohol-related thoughts, more severe depressive symptoms, and decreased cessation self-efficacy (Hoyer et al., 2007). Beliefs like “once craving starts I have no control over my behaviour” and “cravings can drive you crazy” have also been shown to predict abstinence status among treatment-seeking methamphetamine users (Lee et al., 2010).

Similar patterns have been observed among smokers. Spada, Nikčević et al. (2007) found positive correlations between nicotine dependence and three types of S-REF

metacognitive beliefs (positive beliefs about worry, negative beliefs about the uncontrollability and danger of worry and cognitive confidence) in a sample of undergraduate smokers. Nosen and Woody (2009) found significant concurrent correlations between appraisals of cravings and craving severity, cessation self-efficacy, depression, thought suppression and smoking expectancies among smokers who began an attempt to quit smoking within the last 6 months. Metacognition has also been shown to correlate with both smoking and alcohol behaviour (Nosen & Woody, 2009; Spada & Wells, 2005; Spada, Zandvoort, et al., 2007).

One of the key limitations with this body of work is that no studies to date have examined metacognitive beliefs among smokers in the early stages of a cessation attempt, despite the fact that this is likely a temporal period of central relevance. In Nosen and Woody's (2009) study, for example, only a small proportion of the sample reported being in the initial days of their cessation attempt. It is also unknown whether these relationships are consistent across individuals smoking regularly and attempting to quit and how this might vary by cessation success. For example, it is possible that metacognitive beliefs only correlate with craving severity among individuals struggling to quit. People may observe that they are not successful in their efforts to quit and that they are experiencing severe cravings and over-interpret this connection (i.e., this craving means I'm a failure). Successful quitters may still struggle with cravings but be less inclined to overinterpret them. Overall then, the robustness of previously observed cross-sectional correlations is uncertain. The current goal is thus to examine concurrent correlations between metacognitive beliefs and negative affect, responses to smoking-related thoughts, cravings and withdrawal, as predicted by metacognitive models. Correlations will be calculated separately for individuals not actively attempting to quit and for those both successful and unsuccessful in their early abstinence efforts. To the extent that findings are consistent with previous research, moderate-sized, positive correlations were expected between metacognitive beliefs and negative affect, responses to smoking-related thoughts, craving and nicotine withdrawal.

4.2 Methods

4.2.1 Participants

Participants were the full sample of 176 English-speaking adult smokers. See Section 2.2 for full sample details.

4.2.2 Measures

4.2.2.1 Metacognitive Beliefs

The Appraisals of Craving Questionnaire and Catastrophic Appraisals Index (ACQ/CAI), as refined in Section 3, assess how individuals interpret the occurrence of nicotine craving-related thoughts, images or impulses. See Sections 2 and 3 for measure details.

The Metacognition Questionnaire (MCQ-30; Wells & Cartwright-Hatton, 2004) is a 30-item measure assessing five types of metacognitive beliefs, judgments and monitoring tendencies featured in Well's S-REF model. See Section 2.3.2 for details on this measure. Only the subscales assessing positive beliefs, negative beliefs and beliefs about need for control are theoretically relevant to metacognitive models and have demonstrated relationships with cravings and substance use in previous work. As such, cognitive confidence and cognitive self-consciousness subscales were not included in the present analyses.

4.2.2.2 Metacognitive Responses

White Bear Suppression Inventory-Smoking (WBSI; Wegner & Zanakos, 1994). The WBSI is a 15-item self-report questionnaire that measures individuals' tendency to suppress intrusive smoking-related thoughts. See Section 2.3.4 for measure details.

Thought Control Questionnaire (TCQ; Wells & Davies, 1994). The TCQ is a 30-item self-report measure designed to assess use of five strategies of controlling smoking and craving-related thoughts over the between-session monitoring. Current analyses utilize the punishment and worry subscales ("dysfunctional" control strategies; McKay & Greisberg, 2002). See Section 2.3.5 for measure details.

The Ruminative Response Scale-Brief Version (RRS; Nolen-Hoeksema & Morrow, 1991; Treynor et al., 2003) assesses the extent to which people respond to sadness or depressed mood by focusing on self, symptoms, and the causes and consequences of their mood. See Section 2.3.3 for measure details.

4.2.2.3 Negative Affect, Craving and Withdrawal

The *Depression Anxiety Stress Scales* (DASS; Lovibond & Lovibond, 1995) is a 21-item scale assessing depression, anxiety and stress as described by the tripartite model of affect (Clark & Watson, 1991). See Section 2.3.7 for measure details.

The *Questionnaire of Smoking Urges-Brief* (QSU-B; Cox et al., 2001) assesses two aspects of craving severity: "a desire and intention to smoke with smoking perceived as rewarding," and "an anticipation of relief from negative affect with an urgent desire to smoke". See Section 2.3.8 for measure details.

The *Minnesota Nicotine Withdrawal Scale* (MNWS; Hughes & Hatsukami, 1986) measures the experience of eight common nicotine withdrawal symptoms. See Section 2.3.9 for details.

4.2.1 Procedures

Measures were administered as a part of the larger study protocol (see Section 2). Briefly, after assessing study eligibility, participants were asked to select a date to quit smoking within the next two weeks and were then randomly assigned to a cessation condition. Individuals in the cessation attempt condition attended their first lab session (T1) on the day immediately before quitting, while individuals in the anticipated cessation condition attended this session 8 days before their anticipated quit date. During this first lab session, participants completed the ACQ/CAI, MCQ, DASS and QSU-B (prior to receiving any psychoeducation). All participants attended the second lab session four days later (T2), when they completed the same measures, along with the WBSI-S, TCQ, RRS and MNWS.

4.2.2 Analytic Overview

In replication of previous work, concurrent correlations between metacognitive beliefs, distress, metacognitive responses and craving/withdrawal severity were calculated at both T1 and T2. However, correlations at T1 were similar in magnitude to those calculated at T2 in the sample still anticipating their quit attempt at T2 and there were no statistically significant differences in the size of correlations. Given that both samples are smoking regularly, this is to be expected. Thus, T1 correlations are not presented because they do not contribute an appreciable amount of additional information.

A question arising from previous literature is the extent to which cross-sectional correlations are consistent across individuals smoking regularly and attempting to quit and how this might vary by cessation success. As such, correlations were computed separately for individuals anticipating and initiating a cessation attempt at T2 (e.g., due to increased cessation-related variability in cravings, withdrawal). To provide further clarification, individuals initiating a cessation attempt were further divided into those that appeared successful at reducing their smoking (as indicated by both self-reported non-smoking at T2 and CO levels < 8ppm) and those that were not fully successful (any self-reported smoking at T2 and/or CO levels >8ppm).

T2 correlations are expected to be similar across psychoeducation conditions, as the relationship between concurrent metacognitive beliefs and distress, cravings, etc. is not anticipated to change even if metacognitive beliefs change. Congruent with this, correlations within each of the three psychoeducation conditions were similar in magnitude (i.e., were consistently small, medium or large correlations) and there were no statistically significant differences in the size of correlations. As such, psychoeducation groups were combined for the present analyses.

4.3 Results

4.3.1 Are Metacognitive Beliefs Related to Distress, Cravings and Withdrawal?

Table 4 displays concurrent correlations between metacognitive beliefs and negative affect, urge to smoke and withdrawal symptoms at T2. Consistent with previous work, moderate to large correlations were observed between nearly all metacognitive variables and negative affect (i.e., symptoms of depression, anxiety, stress) as well as withdrawal symptoms (e.g., irritability, difficulty sleeping). Effect sizes here appeared fairly consistent among those anticipating a quit attempt (i.e., still smoking regularly) and those who recently initiated either a successful or unsuccessful cessation attempt.

Small to moderate correlations were observed between several metacognitive beliefs (most notably MCQ-negative beliefs, MCQ-need for control and the CAI) and craving. Specifically, individuals experiencing stronger urges to smoke (particularly to relieve negative affect) also reported more negative beliefs about worry (e.g., worrying is dangerous), greater desire for thought control and more "catastrophic" beliefs about smoking-related thoughts (e.g., I will go crazy if I don't control this thought). With a few exceptions, these correlations were only statistically significant among regular smokers. Given that the size of the correlations is nevertheless similar in most cases, this is likely a function of sample size disparities. Comparisons of correlational sizes between cessation groups were not conducted due to limited power (i.e., all differences would not be statistically significant). Interestingly, correlations between craving and the Appraisals of Craving Questionnaire (ACQ) were all small and non-significant.

Table 4

Concurrent Metacognitive Beliefs and Cravings/Withdrawal at T2

	Negative Affect (DASS)			Withdrawal (MNWS 1-7)			Craving: Desire to Smoke (QSU-B-D)			Craving: Need for Relief (QSU-B-R)		
	S	A	UQ	S	A	UQ	S	A	UQ	S	A	UQ
MCQ												
Positive beliefs†	**.40**	**.54**	**.50**	**.28**	**.51**	**.47**	.11	.08	.05	.21	.30	.13
Negative beliefs†	**.71**	**.61**	**.39**	**.54**	**.55**	**.47**	**.34**	.01	.15	**.43**	.23	.27
Need for control	**.55**	**.60**	**.37**	**.34**	**.46**	**.37**	**.22**	.02	.21	**.33**	**.47**	.21
ACQ	**.55**	**.60**	**.37**	**.24**	**.33**	**.38**	.07	.01	.12	.20	.23	.14
CAI	**.30**	**.34**	**.39**	**.40**	**.41**	**.43**	**.22**	.05	.26	**.40**	.26	**.40**

Note: S = Smoking regularly (n = 82), A = Abstinent (n = 39), UQ = Unsuccessful quit (n =43). †Log transformed for analysis. $r_{crit(n = 39, \alpha=.05)}$= .31; $r_{crit(n = 82, \alpha=.05)}$= .22; $r_{crit(n = 43, \alpha=.05)}$= .29.

Given the high correlations between metacognitive beliefs and negative affect, it is possible that the observed relationships between beliefs and withdrawal and cravings are spurious, occurring solely as a function of shared overlap with negative affect. To investigate this possibility, partial correlations controlling for negative affect (T2 DASS total scores) were computed (see Table 5).

Table 5

Partial Correlations - Metacognitive Beliefs and Cravings/Withdrawal at T2

	Withdrawal (MNWS 1-7)			Craving: Desire to Smoke (QSU-B-D)			Craving: Need for Relief (QSU-B-R)		
	S	A	UQ	S	A	UQ	S	A	UQ
MCQ									
Positive beliefs†	.19	**.44**	**.41**	.05	.04	.03	.21	.28	.13
Negative beliefs†	**.40**	**.50**	**.49**	**.25**	.04	.15	**.30**	.14	.27
Need for control	.17	.26	**.34**	.13	.02	.21	.20	**.41**	.20
ACQ	.16	.04	**.36**	.001	-.06	.11	.11	.07	.13
CAI	**.25**	.18	**.35**	.12	-.12	.26	**.38**	.13	**.29**

Note: Partial correlations control for negative affect (T2 DASS total scores). S = Smoking regularly (n = 82), A = Abstinent (n = 39), UQ = Unsuccessful quit (n =43). †Log transformed for analysis. $r_{crit(n = 39, \alpha=.05)}$= .31; $r_{crit(n = 82, \alpha=.05)}$= .22; $r_{crit(n = 43, \alpha=.05)}$= .29

After controlling for negative affect, significant correlations were still present among several metacognitive beliefs and symptoms of withdrawal. Among continuing smokers, individuals who endorsed beliefs that worry and thoughts about smoking are dangerous (MCQ-negative, CAI) endorsed greater symptoms of withdrawal (e.g., elevated irritability, difficulty sleeping). Among abstinent smokers, withdrawal symptoms correlated with beliefs that worry is both dangerous (MCQ-negative) and useful (MCQ-positive; e.g., worrying helps avoid problems). Among continuing smokers, withdrawal correlated significantly with all metacognitive beliefs subscales (MCQ, ACQ, CAI). Controlling for negative affect reduced correlations between metacognitive beliefs and craving, although significant relationships remained between beliefs that smoking-related thoughts are dangerous (CAI) and urge to smoke for relief in both continuing smokers and unsuccessful quitters. Beliefs that worry-related thoughts are dangerous (MCQ-neg) also correlated with urge to smoke for relief among continuing smokers, while beliefs about need for control (MCQ-nc) correlated with urges for relief among abstinent smokers.

4.3.2 Are Metacognitive Beliefs Related to Responses to Thoughts?

Table 6 displays concurrent correlations between metacognitive beliefs and responses to thoughts. As anticipated, moderate to large correlations were observed between metacognitive beliefs and several thought control strategies traditionally considered "maladaptive", including punishment, worry and rumination. Thought suppression was correlated with need for control and the ACQ (which also includes items related to desire for control), among people unsuccessfully attempting to quit smoking, but not among people smoking regularly.

Table 6

Concurrent Metacognitive Beliefs and Responses at T2

	Suppress			Worry†			Punish†			Brooding		
Measure	S	A	UQ	S	A	UQ	S	A	UQ	S	A	UQ
MCQ												
Positive beliefs†	.16	.11	.25	**.46**	**.35**	**.54**	**.33**	.20	**.64**	**.32**	**.64**	**.50**
Negative beliefs†	.14	.04	.08	**.57**	.17	**.45**	**.53**	.26	**.50**	**.70**	**.58**	**.63**
Need for control	.14	.01	**.41**	**.32**	**.37**	**.37**	**.57**	**.35**	**.70**	**.40**	**.38**	**.42**
ACQ	.14	.18	**.32**	**.28**	**.46**	**.50**	**.39**	**.58**	**.52**	**.38**	.29	**.34**
CAI	.12	.06	.02	**.46**	**.55**	**.55**	**.64**	**.59**	**.71**	**.43**	**.33**	**.45**

Note: S = Smoking regularly (n = 82), A = Abstinent (n = 39), UQ = Unsuccessful quit (n =43).
†Log transformed for analysis. $r_{crit(n = 39, \alpha=.05)}$= .31; $r_{crit(n = 82, \alpha=.05)}$= .22; $r_{crit(n = 43, \alpha=.05)}$= .30

Partial correlations were again computed to investigate relationships between beliefs and responses to thoughts independent of shared variance with negative affect (see Table 7). With few exceptions, correlations remained unchanged after partialing out T2 DASS scores.

Table 7

Partial Correlations - Metacognitive Beliefs and Responses at T2

	Suppress			Worry†			Punish†			Brooding		
Measure	S	A	UQ	S	A	UQ	S	A	UQ	S	A	UQ
MCQ												
Positive beliefs†	.18	.11	.24	**.40**	**.36**	**.50**	**.26**	.12	**.61**	**.24**	**.60**	**.46**
Negative beliefs†	.17	.04	.07	**.42**	.17	**.45**	**.43**	.18	**.51**	**.61**	**.53**	**.63**
Need for control	.16	.02	**.40**	.14	**.38**	**.34**	**.50**	.25	**.71**	**.25**	.27	**.40**
ACQ	.14	.22	**.32**	.20	**.48**	**.48**	**.34**	**.52**	**.51**	**.32**	.14	**.32**
CAI	.14	.09	.04	**.31**	**.58**	**.50**	**.57**	**.53**	**.68**	**.30**	.22	**.40**

Note: Partial correlations control for negative affect (T2 DASS total scores). S = Smoking regularly (n = 82), A = Abstinent (n = 39), UQ = Unsuccessful quit (n =43). †Log transformed for analysis. $r_{crit(n = 39, \alpha=.05)}$= .31; $r_{crit(n = 82, \alpha=.05)}$= .22; $r_{crit(n = 43, \alpha=.05)}$= .30

4.4 Summary

4.4.1 Negative Affect, Withdrawal and Craving

The first aim of the present study was to replicate previously observed cross-sectional correlations between metacognitive beliefs and negative affect, withdrawal and craving in a biochemically verified sample of community smokers and to identify any potential differences based on cessation status. Consistent with previous work (e.g., Nosen & Woody, 2009), moderate to large correlations were observed between nearly all measures of metacognitive

beliefs and symptoms of stress, anxiety and depression. People who were experiencing more negative affect were more likely to endorse beliefs that cravings are a negative reflection on oneself (e.g., “I’m weak”) or one’s quit attempt (e.g., “I’m destined to fail”). Similarly, people who believed that worrying is helpful in certain ways but is also potentially dangerous and important to control simultaneously experienced higher levels of stress, anxiety and depression. These concurrent relationships were observed both among those smoking regularly and those who recently initiated a cessation attempt (successfully or not).

Moderate correlations were also observed between several metacognitive beliefs (most notably MCQ-negative beliefs, MCQ-need for control, and the CAI) and several indicators of withdrawal, including desire to smoke for relief and other withdrawal symptoms. That is, more severe craving and withdrawal symptoms were associated with stronger beliefs that cravings are a negative reflection on oneself (e.g., “I’m weak”) or one’s quit attempt (e.g., “I’m destined to fail”), and beliefs that worrying is helpful, potentially dangerous and important to control. Correlations between metacognitive beliefs and withdrawal symptoms were robust across cessation groups and measures of beliefs. With cravings, however, correlations were generally only statistically significant among regular smokers (albeit with a few exceptions) and only for a few of the measures (MCQ-Negative, MCQ-Need for Control, CAI). This may have been a function of insufficient power to detect small effects in the case of the QSU-B-relief subscale, where the magnitude of correlations was small but fairly consistent across groups and measures. For the QSU-B-desire subscale, however, correlations were close to zero for individuals successfully abstaining from cigarettes. While a larger sample of abstaining smokers would be required to test whether these correlations are statistically different in magnitude across cessation status, this is consistent with the idea that some successful quitters may still struggle with cravings but be less inclined to overinterpret them.

Controlling for T2 symptoms of depression, anxiety and stress (i.e., negative affect) reduced some correlations between metacognitive beliefs, withdrawal and craving, but not all.

Beliefs that smoking-related thoughts are dangerous (CAI), in particular, continued to correlate with greater withdrawal and urge to smoke for relief among both continuing smokers and unsuccessful quitters. Of note, correlations between craving and the Appraisals of Craving Questionnaire (ACQ) were all small and non-significant. This may have relevance for understanding the results of the psychoeducation manipulation (see Section 5), which focuses on the types of appraisals targeted by the ACQ. If there is no relationship between the ACQ and QSU-B, it is unlikely that reducing ACQ-types of appraisals would produce any effect on cravings as measured by the QSU-B.

Overall, this work is generally consistent with findings both from Nosen and Woody (2009), who found positive correlations between the ACQ/CAI and symptoms of depression among relatively recent quitters, and from Spada, Nikčević et al. (2007), who found that metacognitive beliefs partially mediated the relationship between negative emotions and nicotine dependence in regular smokers. The present work is the first to demonstrate these correlations among biochemically verified regular smokers and smokers in the first several days of a quit attempt. Naturally, it is important to keep in mind that the directionality of these relationships is unknown. These correlations could be a function of something akin to mood-congruent information processing, such that people feeling more depressed, anxious and stressed or experiencing greater withdrawal or craving, might cause people to think about themselves and their cravings in a more negative light. Alternatively, viewing one's thoughts and cravings as important and negative indicators of one's mental stability, personal wellbeing etc. may also cause people to feel distressed. As implied by metacognitive models, these possibilities are not mutually exclusive. Subsequent chapters will provide further insight into this issue.

4.4.2 Responses to Cravings

Moderate to large correlations were observed between nearly all measures of metacognitive beliefs (but particularly the MCQ-negative and CAI) and punishment, worry and

rumination. That is, these theoretically maladaptive responses to thoughts were more common among people who believe that cravings are a negative reflection on oneself (e.g., “I’m weak”) or one’s quit attempt (e.g., “I’m destined to fail”), and among those who believe that worrying is helpful, potentially dangerous and important to control. These concurrent relationships were observed both among those smoking regularly and those who recently initiated a cessation attempt. Metacognitive models predict that overinterpreting the personal significance of cravings prompts individuals to punish, ruminate and worry. Bidirectional effects are also plausible, whereby spending too much time berating oneself or pontificating over the meaning of one’s thoughts may reinforce beliefs in the importance and personal significance of cognition.

Thought suppression was only significantly correlated with metacognitive beliefs tapping the need to control thoughts (MCQ-need for control, ACQ), and only then among individuals who had recently initiated an unsuccessful cessation attempt. This is interesting and suggests that studies of suppression in relation to metacognitive beliefs may not necessarily be equivalent among abstinent and non-abstinent samples. Why would suppression correlate with desires for control among people struggling to quit, but not among regular smokers or successful quitters? One possibility is that smokers not attempting to quit may desire control but do not make efforts to obtain it because they are not actively trying to reduce their smoking. In other words, these individuals may simply smoke when they want their craving-related thoughts to disappear. Successful quitters, on the other hand, may also desire control, but they may use varying amounts of thought suppression to achieve it. That is, successful quitters may use a variety of techniques to ameliorate cravings in addition to suppression--chewing gum, going for a walk or drinking ice water, for example. This is consistent with evidence indicating that long-term quitters use multiple coping techniques in supplement to cognitive strategies, including deep breathing and physical activity (Bliss et al., 1989; O'Connell, Fears, Cook, Gerkovich, & et al., 1991; Ortendahl & Nasman, 2007; Shiffman, 1984b; Shiffman, Gnys, et al., 1996). O’Connell, Hosein and Schwartz (2006), for example, found that use of more than one coping

strategy (of which at least one was cognitive) afforded maximum likelihood of successful abstinence. More flexible coping among successful quitters may reduce the correlation between suppression and desire for control, while more inflexible coping/reliance on suppression may increase it. Thus, overreliance on suppression may be more problematic than simple use alone.

Why wouldn't correlations be observed between suppression and more catastrophic-type beliefs (CAI) or beliefs about the benefit or danger of worry? It is possible that suppression is driven by a variety of factors, only one of which may be metacognitive beliefs. For example, people who view cravings as an unimportant but annoying side effect of cessation may score low on the ACQ, CAI and MCQ but might nevertheless try to suppress thoughts about smoking because they perceive suppression to be a functional coping strategy (e.g., one that reduces distraction or discomfort more than constantly thinking about craving). This possibility is consistent with the observed correlations between suppression and the ACQ and MCQ-need for control scales (both tapping the perceived utility of controlling cravings) and the more theoretically adaptive strategies like distraction and re-appraisal (all potentially related to stronger coping efforts). The possibility that smokers view suppression as a potentially useful coping strategy is consistent with previous research suggesting that almost *all* smokers report suppressing cravings during cessation (Salkovskis & Reynolds, 1994) and that focusing thoughts away from smoking is a common and efficacious coping technique (O'Connell et al., 2007).

Chapter 5: Metacognition and Nicotine Withdrawal: Examining Causality

5.1 Introduction

Results of the current study (see Section 4) are congruent with previous work indicating that some smokers appraise craving-related thoughts as important but negative signals of the type of person they are or the likely success of their quit attempt. Consistent with metacognitive models, individuals who endorsed these beliefs reported higher levels of depression, anxiety and stress and subjective nicotine withdrawal symptoms. They also engaged in more punishment, worry and rumination and experienced somewhat stronger urges to smoke to relieve negative affect.

Longitudinal and experimental research is needed to establish the temporal and causal relationships underlying these correlations. Metacognitive models predict that negative, overly significant interpretations of cravings prompt distress and maladaptive craving control efforts (i.e., punishment, worry, rumination), which in turn increase cravings. In other words, beliefs are the underlying causative factor. However, it is just as plausible that the directional pathway is actually reversed, such that experiencing more severe craving, withdrawal and negative affect prompts maladaptive control efforts and overly pessimistic thinking about craving. For example, recurrent cravings may confirm initial suspicions about the meaning of the thoughts (e.g., "the fact that this urge keeps returning proves that it really does mean something about me / that I'm destined to fail / that I'm not fighting hard enough). Nicotine withdrawal also increases anxiety, depression, and irritability (Hughes, 2007). Consistent with mood-congruent information processing effects, distress may encourage people to think about their cravings in more negative, overly catastrophic ways. It may also be that both directional pathways are operational, such that maladaptive appraisals, severe cravings and negative mood form mutually reinforcing relationships that propel an escalating cycle of distress and craving.

The second aim of the present study is to begin disentangling the directionality of these correlational relationships. Towards this aim, smokers interested in quitting were randomly

assigned to one of two cessation conditions: smoking cessation attempt started (lab sessions encompass first few days of cessation) vs. anticipated (lab sessions prior to cessation). When arriving at the lab, participants were assigned to one of three psychoeducation conditions (metacognitive vs. non-metacognitive vs. no psycho-ed control). The *metacognitive* condition aimed to reduce and correct maladaptive appraisals and responses to craving-related thoughts, images and impulses. The *non-metacognitive* control condition provided psychoeducation about risk factors for smoking and commonly used cessation techniques. The *no psychoeducation* control condition provided a comparison group who did not receive an interactive psychoeducation intervention.

To the extent that metacognitive beliefs have a direct causal impact on cravings, providing information discouraging overly negative appraisals of craving-related thoughts is expected to decrease distress, theoretically problematic responses to nicotine cravings (i.e., suppression and rumination) and severity of cravings during smoking cessation, relative to control conditions. As a test of the reverse directional pathway, quitting smoking (and associated increases in craving, withdrawal and distress) is anticipated to cause people to think more negatively about their cravings and quit attempt (i.e., cessation will increase maladaptive beliefs).

5.2 Methods

5.2.1 Participants

Participants were the full sample of 176 English-speaking adult smokers interested in quitting. See Section 2 for full sample details.

5.2.2 Measures

5.2.2.1 Metacognitive Beliefs

The Appraisals of Craving Questionnaire and Catastrophic Appraisals Index (ACQ/CAI), as refined in Section 3, assess how individuals interpret the occurrence of nicotine craving-related thoughts, images or impulses. See Sections 2 and 3 for measure details

5.2.2.2 Metacognitive Responses

White Bear Suppression Inventory-Smoking (WBSI; Wegner & Zanakos, 1994). The WBSI is a 15-item self-report questionnaire that measures individuals' tendency to suppress intrusive smoking-related thoughts. See Section 2.3.4 for measure details.

Thought Control Questionnaire (TCQ; Wells & Davies, 1994). The TCQ is a 30-item self-report measure designed to assess use of five strategies of controlling smoking and craving-related thoughts over the between-session monitoring. Current analyses utilize the punishment and worry subscales ("dysfunctional" control strategies; McKay & Greisberg, 2002). See Section 2.3.5 for measure details.

The Ruminative Response Scale-Brief Version (RRS; Nolen-Hoeksema & Morrow, 1991; Treynor et al., 2003) assesses the extent to which people respond to sadness or depressed mood by focusing on self, symptoms, and the causes and consequences of their mood. See Section 2.3.3 for measure details.

5.2.2.3 Negative Affect, Craving and Withdrawal

The *Depression Anxiety and Stress Scale* (DASS; Lovibond & Lovibond, 1995) is a 21-item scale assessing depression, anxiety and stress as described by the tripartite model of affect (Clark & Watson, 1991). See Section 2.3.7 for measures details.

The *Questionnaire of Smoking Urges-Brief* (QSU-B; Cox et al., 2001) assesses two aspects of craving severity: "a desire and intention to smoke with smoking perceived as rewarding," and "an anticipation of relief from negative affect with an urgent desire to smoke". See Section 2.3.8 for measure details.

The *Minnesota Nicotine Withdrawal Scale* (MNWS; Hughes & Hatsukami, 1986) measures the experience of eight common nicotine withdrawal symptoms. See Section 2.3.9 for details.

5.2.3 Procedures

Measures were administered as a part of the larger study protocol (see Section 2 for details). Briefly, after assessing study eligibility, participants were asked to select a date to quit smoking within the next two weeks and were then randomly assigned to a cessation condition. Individuals in the cessation attempt condition attended their first lab session (T1) on the day immediately before quitting, while individuals in the anticipated cessation condition attended this session 8 days before their anticipated quit date. During this first lab session, participants completed the ACQ/CAI, DASS and QSU-B (prior to receiving any psychoeducation).

Following this, participants were randomly assigned to one of the three experimental psychoeducation conditions (see Section 2.5.2.1 for details). In the *metacognition* condition, this presentation focused on the nature of cravings and thoughts about smoking, with the goal of reducing maladaptive appraisals and responses to craving-related thoughts, images and impulses. In the *psychoeducation control* condition, discussion focused on smoking risk factors and common cessation methods, with the goal of matching the metacognitive discussion's level of information, relevance to smoking cessation, experimenter attention, and participant involvement. This condition was not expected to produce any observable changes in measures of metacognition. However, talking to participants about cessation and encouraging use of effective coping were important to control for as they may incidentally boost cessation self-efficacy and perhaps even success. The *no psychoeducation control* condition was intended as a second comparison group that does not provide these non-specific treatment effects. In this condition, participants did not receive any supplementary psychoeducation and instead spent time completing a few additional questionnaires.

To check group equivalence on non-specific presentation qualities, participants also completed visual analogue scale ratings of the intervention (i.e., how engaging, interesting, novel and relevant they found the discussion) and the ACQ/CAI and QSU-B at the end of T1. In total, the psychoeducational presentations took approximately 1 to 1.5 hours, depending upon

the pace with which the participant completed the questions during the presentation. All participants attended the second lab session four days later (T2), when they completed the ACQ/CAI, DASS and QSU-B again, along with the WBSI, TCQ, RRS and MNWS.

5.2.4 Analytic Overview

Data were first checked for fit with multivariate assumptions (see Section 2.6), failures of randomization and success of the experimental manipulations. Next, a series of 2 x 3 analyses of covariance was conducted to assess causal effects of experimentally assigned groups (i.e., metacognition psychoeducation vs. psychoeducation control vs. no psychoeducation control; cessation attempt started vs. smoking regularly) on metacognition, craving severity and withdrawal symptoms. In each analysis, T1 pretest scores are included as covariates when available. Researchers recommend using the ANCOVA approach over a repeated measures ANOVA for pre-post designs because the ANCOVA is more statistically appropriate, more powerful and better accounts for regression to the mean (Dugard & Todman, 1995; Frison & Pocock, 1992; Huck & McLean, 1975; Jennings, 1988).

Because the mechanism of the cessation effect is theoretically related to the success and level of withdrawal symptoms experienced during smoking cessation, analyses were also conducted to examine group differences based on cessation success (i.e., successful attempt vs. “failed” attempt vs. smoking regularly) and to examine prospective correlational relationships (e.g., testing whether increase in craving predicts increase in metacognition). Similarly, non-experimental analyses were conducted to examine whether changes in metacognition were predictive of changes in cravings and withdrawal.

5.3 Results

5.3.1 Checking for Failures in Randomization

Several 2 x 3 MANOVAs were conducted on sample demographics and baseline measures to check for failures in randomization. Analyses of demographic variables (age, gender, ethnicity (other vs. Caucasian), years of education) suggested a lack of omnibus

differences between cessation conditions, F (4, 167) = .52, p = .73, psychoeducation group, F (8, 336) = 1.62, p = .12, or interactive effects, F (8, 336) = 0.92, p = .50. Analyses of baseline metacognition-relevant variables (ACQ, CAI, MCQ, RRS) also indicated a lack of omnibus differences between cessation conditions, F (10, 160) = .86, p = .57, psychoeducation group, F (20, 322) = 1.11, p = .34, or interactive effects, F (20, 322) = 1.33, p = .16. Analyses of baseline smoking-related variables (craving, nicotine dependence, longest duration abstinent, number times previously quit, average amount currently smoking, years smoking regularly, cessation goal, expired CO levels) also showed no omnibus differences between cessation conditions, F (20, 148) =0.98, p = .48, psychoeducation group, F (40, 298) = 0.67, p = .94, or interactive effects, F (40, 298) = 0.99, p = .50. Thus, it appears that groups did not differ significantly prior to the experimental manipulations.

5.3.2 Manipulation Checks

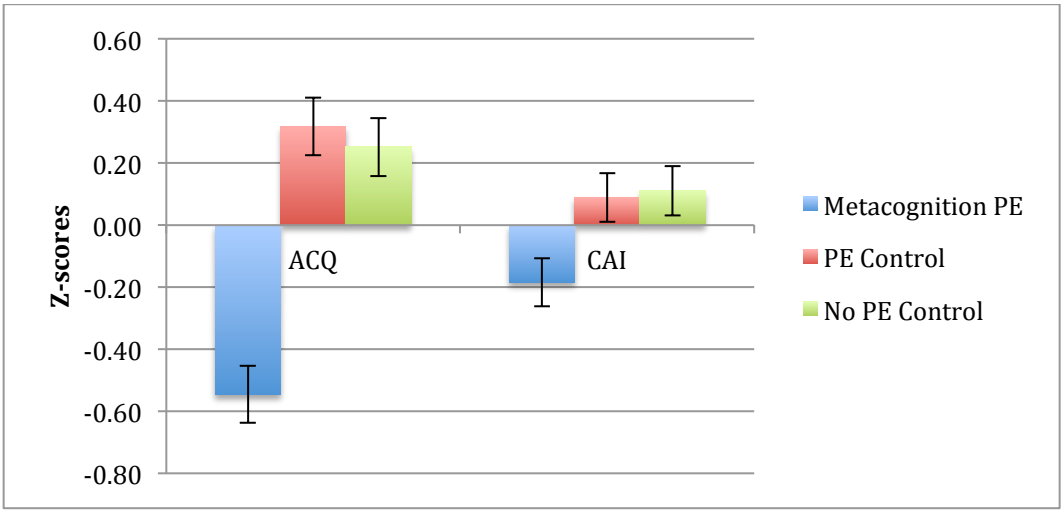
5.3.2.1 Metacognitive Psychoeducation

Psychoeducation presentations were intended to share similar nonspecific characteristics. Confirming this, an omnibus Hotelling's T analysis indicated that participants rated the two psychoeducational presentations similarly on levels of interest, clarity, enjoyment, novelty, motivation, relevance and the extent to which presentations left them feeling prepared and confident to quit smoking, F (8, 100) = 1.103, p = .37. All three conditions were also expected to also display similar levels of craving severity following the presentations. Indeed, ANCOVAs of craving (QSU-B) subscales (covarying out pre-test scores), showed an absence of significant between-group differences on both the QSU-B-desire, F (2, 163) = 1.66, p =.19, and QSU-B-relief, F (2, 163) = 1.99, p =.14.

The metacognition manipulation was checked using ACQ and CAI ratings provided at the very end of the first lab session (approximately 15 minutes after the presentation) with ANCOVAs (covarying out pretest scores). Analyses showed significant between-group differences on both the ACQ, F (2, 167) = 27.08, p <.001, η^2 = .25 (medium effect size) and

CAI, F (2, 167) = 4.38, p =.01, η^2 = .05 (small effect size). Figure 3 displays standardized post-presentation means and standard errors across groups. Testing of simple effects confirmed that after covarying out T1 scores, post-presentation ACQ and CAI scores were significantly lower for individuals in the metacognition condition than for those in the both the psychoeducation control (ACQ: t = *6.56* p < .001; CAI: t = *2.70*, p = .008) and non-psychoeducation control groups (ACQ: t = *5.26*, p < .001; CAI: t =2.23, p = .03). This suggests that maladaptive appraisals were reduced successfully by the metacognition psychoeducation. The two control groups did not differ on post-presentation ACQ and CAI scores, *t*'s (113) > 0.87, *p's* > .75.

Figure 3. Manipulation Check: Post-Presentation Metacognitive Beliefs



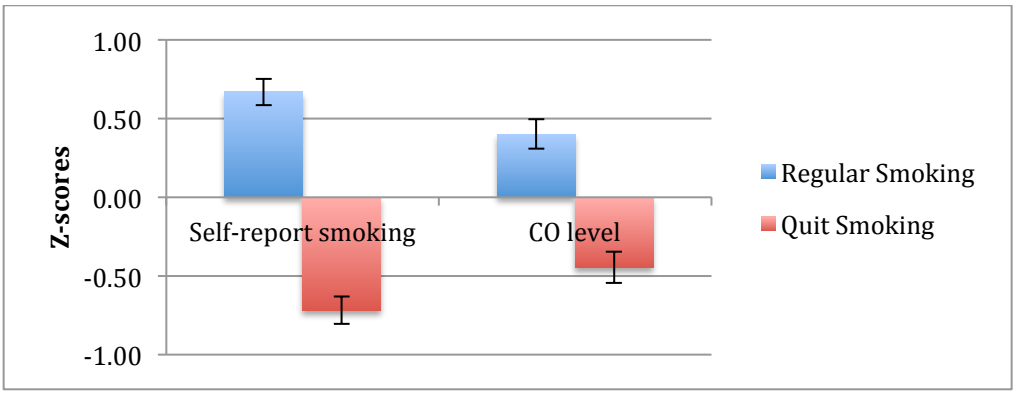
Note: Scores represent standardized means at the end of day 1, following psychoeducation (adjusted for baseline). ACQ = Appraisals of Craving Questionnaire, CAI = Catastrophic Appraisals Index, PE = Psychoeducation

5.3.2.2 Cessation Manipulation

The cessation manipulation was checked using expired CO levels and self-reported smoking behaviour (average number of cigarettes smoked per day) at T2 with ANCOVAs that covaried out pretest scores. Figure 4 displays T2 z-scores and standard errors. Analyses indicated that individuals assigned to quit smoking demonstrated significantly lower T2 self-reported smoking, t (113) = 11.46, p <.001, η^2 = .54, and CO levels, t (113) = 6.25, p <.001, η^2

= .26. This suggests that participants generally complied with smoking cessation instructions.

Figure 4. Manipulation Check: Smoking and CO level at T2



Note: Scores represent standardized means at T2 (adjusted for T1).

5.3.3 Main Experimental Analyses

Raw T2 means and standard deviations for primary study measures across the experimental conditions are presented in Tables 8 and 9, broken down by psychoeducation condition and cessation status. ANOVAs were conducted to test the effects of experimental manipulations on T2 metacognitive appraisals (ACQ, CAI) and withdrawal, craving severity, negative affect (QSU-B-desire, QSU-B-relief, MNWS, DASS). When available, T1 scores were included as covariates to reduce the contribution of individual variability to error.

Table 8

Metacognitive Beliefs and Responses: Raw Means (SDs) at T2

	Metacognition Psychoed			Psychoed Control			No Psychoed Control		
Measure	S	A	UQ	S	A	UQ	S	A	UQ
n	31	9	19	24	16	11	27	14	13
Appr. of Craving (ACQ)	36.55 (29.90)	32.82 (22.64)	45.10 (25.45)	56.87 (20.67)	47.53 (22.34)	61.96 (9.77)	44.93 (23.52)	51.83 (17.60)	49.11 (19.26)
Extreme appr. (CAI)	3.42 (3.99)	3.56 (3.43)	4.58 (4.23)	5.33 (4.11)	4.81 (4.02)	4.18 (3.71)	4.03 (3.28)	5.14 (4.22)	3.85 (4.26)
Punishment (TCQ)	7.96 (2.74)	7.11 (1.27)	9.89 (3.70)	8.88 (2.44)	9.31 (4.32)	8.09 (1.44)	7.67 (1.96)	8.35 (3.12)	8.85 (2.51)
Worry (TCQ)	8.69 (2.31)	9.11 (2.31)	10.10 (3.31)	9.71 (3.09)	9.75 (3.89)	9.18 (2.27)	9.11 (3.05)	8.57 (2.84)	10.00 (3.21)
Suppress. (WBSI)	3.43 (0.85)	3.44 (0.91)	3.72 (0.78)	3.47 (0.69)	3.85 (0.55)	3.74 (0.67)	3.27 (0.74)	3.98 (0.48)	4.05 (0.56)
Brooding (RRS)	11.19 (3.87)	12.56 (2.79)	13.50 (3.84)	11.83 (3.49)	12.75 (3.66)	11.54 (3.41)	11.52 (3.57)	11.00 (3.76)	10.62 (3.82)
Distraction (TCQ)	14.21 (3.90)	15.78 (2.79)	16.37 (3.40)	14.33 (4.68)	16.81 (3.03)	17.09 (3.96)	13.86 (4.02)	16.86 (2.66)	16.15 (4.04)
Reappraisal (TCQ)	11.85 (3.06)	14.00 (3.87)	11.85 (3.06)	11.58 (3.35)	13.06 (3.80)	13.18 (3.60)	10.89 (3.82)	12.71 (3.22)	11.85 (2.23)

Note: S = Smoking regularly, A = Abstinent, UQ = Unsuccessful quit. [T]Log transformed for analysis; raw scores presented in table.

Table 9

Smoking, Withdrawal and Craving: Raw Means (SDs) at T2

Measure	Metacognition Psychoed			Psychoed Control			No Psychoed Control		
	S	A	UQ	S	A	UQ	S	A	UQ
n	32	9	20	24	16	13	29	14	14
DASS Total	24.42 (19.20)	24.00 (22.00)	38.32 (21.25)	28.55 (26.37)	32.56 (24.12)	25.64 (11.16)	24.58 (20.91)	28.57 (21.14)	33.77 (19.14)
Craving - Desire (QSU-B)	3.64 (1.94)	2.87 (1.43)	3.35 (1.23)	3.30 (1.70)	2.35 (1.12)	3.75 (1.81)	3.67 (1.64)	2.69 (1.17)	2.57 (1.36)
Craving - Relief (QSU-B)	2.95 (1.66)	2.18 (1.14)	2.67 (1.06)	2.74 (1.36)	2.21 (1.51)	2.79 (1.32)	2.59 (1.29)	2.38 (1.17)	1.82 (0.88)
Withdrawal (MNWS)	15.97 (6.46)	16.33 (5.92)	21.59 (6.86)	15.46 (5.79)	20.37 (6.09)	18.91 (4.81)	15.95 (7.39)	19.21 (5.94)	19.89 (5.88)
Cigs/day over 3-day monitoring	11.82 (8.60)	0.52 (0.91)	4.65 (3.51)	12.44 (7.72)	0.25 (0.43)	2.01 (1.26)	14.23 (6.54)	1.77 (2.36)	2.42 (2.44)
CO level	22.47 (9.54)	3.89 (2.26)	17.58 (9.17)	23.54 (12.20)	3.69 (1.53)	11.33 (4.81)	23.21 (8.70)	5.79 (4.74)	18.46 (11.38)

Note: S = Smoking regularly, A = Abstinent, UQ = Unsuccessful quit. DASS = Depression, Anxiety and Stress Scale.

5.3.3.2 Experimental Effects on Metacognitive Beliefs

5.3.3.2.1 Review of Hypotheses

While the metacognitive model suggests that relationships between beliefs and withdrawal/craving/negative affect is primarily due to the impact of maladaptive beliefs on urge severity, a plausible reverse causal pathway suggests that experiencing an increase in withdrawal, distress and urges to smoke encourages pessimistic thinking about cravings. One of the ways the current study explores the directionality of this relationship is via the smoking cessation manipulation. Quitting smoking (and associated increases in craving, withdrawal and distress) is anticipated to cause people to think more negatively about their cravings and quit attempt. In other words, cessation is predicted to have a main effect on maladaptive beliefs.

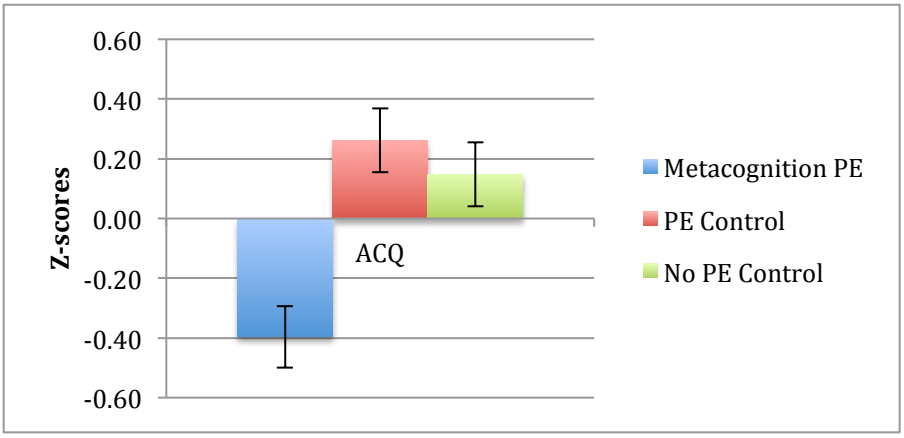
As for the impact of manipulating metacognition, while problematic appraisals of cravings decreased following metacognitive psychoeducation, it is unknown what impact this change will have on later thinking. It is possible that change in metacognitive beliefs associated with the psychoeducation condition may persist four days later (consistent with a main effect of

psychoeducation condition) but may also be dependent on whether people quit smoking or not (i.e., an interaction between psychoeducation and cessation).

5.3.3.2.2 ANCOVAS: Effects on Metacognitive Beliefs

When T2 appraisals of craving (ACQ) scores were used as the dependent variable, 2 (cessation date) x 3 (psychoeducation condition) ANCOVAs (covarying out baseline T1 scores) showed a significant main effect of psychoeducation condition, F (2, 162) = 11.38, p <.001, η^2 = .12 (small to medium effect size). The main effect of cessation condition was not significant, F (1, 162) = 0.06, p =.80, η^2 < .001, nor was the interaction between cessation and psychoeducation conditions, F (2, 162) = 0.43, p =.65, η^2 = .005. Figure 5 displays T2 ACQ z-scores and standard errors across groups. Testing of simple effects indicated that after covarying out T1 scores, T2 ACQ were significantly lower for individuals in the metacognition condition than for those in the both the psychoeducation control, t = *4.22* p < .001, η^2 = .14, and non-psychoeducation control groups, t = 3.53, p < .001, η^2 = .10. The two control groups did not differ on T2 ACQ scores, t (113) = 0.95, p = *.32*, η^2 = .009.

Figure 5. T2 Metacognitive Beliefs by Psychoeducation Condition



Note: Scores represent standardized means at T2 (adjusted for T1). ACQ = Appraisals of Craving Questionnaire, PE = Psychoeducation, N = 167

When T2 Catastrophic Appraisals Index (CAI) scores were used as the dependent variable, 2 (cessation date) x 3 (psychoeducation condition) ANCOVAs indicated that there were no significant differences between psychoeducation conditions, F (2, 162) = 1.08, p =.34, η^2 = .01, or between cessation conditions, F (1, 162) = 0.39, p =.53, η^2 = .002, nor was there a significant interaction, F (2, 162) = 0.39, p =.68, η^2 = .005.

5.3.3.3 Change in Beliefs as a Function of Non-Experimental Predictors

While there was not a significant main effect of cessation on maladaptive beliefs, it is possible that this effect was not observed because it is theoretically contingent on cessation producing a consistent increase in craving, withdrawal and negative affect. However, cessation does not produce perfect effects in this regard—some individuals in the cessation condition had relapsed by T2 (and thus may have been back to baseline levels of craving, negative affect, etc.) while others may have been coping so effectively that they did not experience noticeable increases in craving, withdrawal and negative affect. Thus, inclusion of both successful and unsuccessful quitters in the same group could obscure differences between individuals smoking regularly versus attempting to quit.

To help clarify, two additional sets of analyses were conducted. First, ANCOVAs were repeated with the cessation manipulation broken down based on cessation outcome (i.e., "successful" attempt vs. "failed" attempt vs. smoking regularly). Second, regression analyses were conducted across groups to examine whether changes in cravings, withdrawal and negative affect were predictive of changes in metacognition. While causal conclusions cannot be drawn from these analyses, these nonexperimental analyses are intended to provide additional tests of the hypothesis that increases in craving, withdrawal and distress lead people to think more negatively about their cravings and quit attempt.

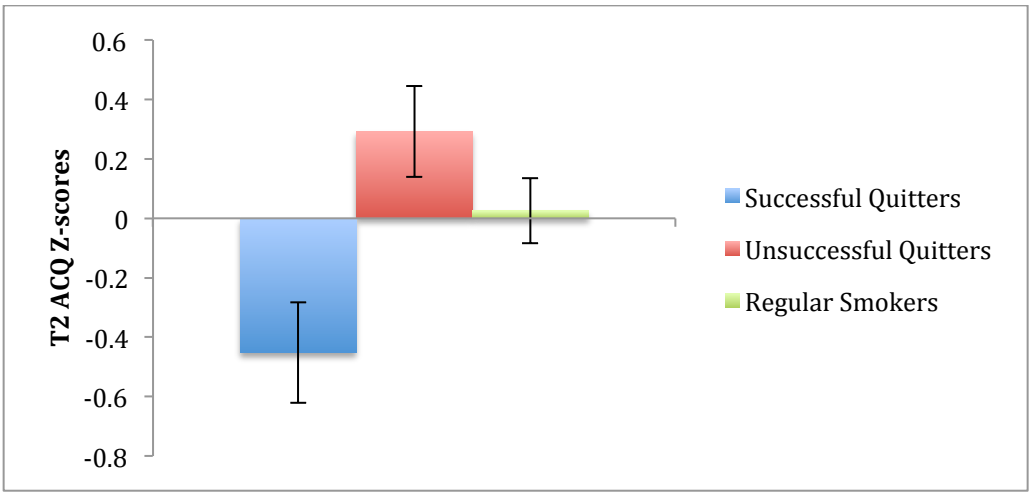
5.3.3.3.1 Do Metacognitive Beliefs Differ by Cessation Outcome?

Individuals initiating a cessation attempt were divided into those that appeared successful at reducing their smoking (as indicated by both self-reported non-smoking at T2 and

CO levels < 8ppm; n = 39) and those that were not fully successful (any self-reported smoking at T2 and/or CO levels >8ppm; n = 47). Individuals who appeared to initiate a quit attempt despite being instructed to smoke regularly (n = 5) were removed from the group of regular smokers (n = 85).

3 x 3 ANCOVAs indicated that when T2 ACQ scores were used as the dependent variable, ANCOVAs showed a significant main effect of both psychoeducation condition, F (2, 154) = 13.49, p <.001, η^2 = .15 *and* cessation status, F (1, 154) = 4.18, p =.02, η^2 = .05. There was no interaction between cessation and psychoeducation conditions, F (4, 154) = 1.51, p =.35, η^2 = .03. Analysis of simple effects of psychoeducation indicated that T2 ACQ were significantly lower for individuals in the metacognition condition than for those in the both the psychoeducation control, t = 4.68, p < .001, η^2 = .18, and non-psychoeducation control groups, t = 4.03, p < .001, η^2 = .13. The two control groups did not differ on T2 ACQ scores, t (98) = 1.10, p = *.30*, η^2 = .01. Analysis of simple effects of cessation status indicated that T2 ACQ scores were significantly lower for individuals who successfully abstained from smoking than for those who failed to abstain, t = 2.88, p = .005, η^2 = .10. Continuing smokers had T2 ACQ scores that were marginally higher than successful quitters, t (115) = 1.77, p = .08, η^2 = .03, and marginally lower than unsuccessful quitters, t (119) = 1.64, p = .10, η^2 = .02. Figure 6 displays T2 ACQ z-scores and standard errors across cessation status. There were no significant main effects or interactions when T2 CAI was used as the DV, *F's* (2/4, 154) ≤ 1.21, *p's* ≥ .30, η^2 's ≤ .02.

Figure 6. T2 Metacognitive Beliefs by Cessation Outcome Status



Note: Scores represent standardized residualized gain scores on the Appraisals of Craving Questionnaire at T2.

5.3.3.3.2 Does Change in Smoking Variables Predict Change in Beliefs?

Continuing to follow-up on the nonsignificant cessation start date manipulation, multiple regression analyses examined whether the change in craving (QSU-B subscales), average number of cigarettes smoked per day (log transformed) and negative affect (DASS) predicted change in metacognitive beliefs (i.e., the ACQ and CAI). Residualized change scores were used to adjust for baseline, calculated as YT2-YT2', where YT2 is the value of the variable at T2 and YT2' is the predicted value of the T2 variable using the observed T1 variable (Tracy & Rankin, 1967). As such, positive and negative scores reflect more and less change at T2, respectively, than is predicted by T1 alone. They were used because residualized change scores are appropriate when regression to the mean is assumed to occur over time and when correlations between measurements is high (MacKinnon, 2008).

Correlations between residualized gain scores are presented in Table 10. When residualized change in ACQ scores was the dependent variable, the overall multiple regression model with four predictors (craving subscales, number of cigarettes smoked per day and negative affect) was significant, F (4, 163) = 2.57, p= .04, R^2 = .06. Examination of the

individual contribution of predictors indicated that this effect was largely driven by change in negative affect. Specifically, when holding the other predictors constant, change in DASS scores predicted change in ACQ scores, β = .23, t = 2.84, p = .005. However, change in QSU-B relief, QSU-B desire and average cigarettes per day did not predict change in metacognitive appraisals, β's ≤ .09, |t's| ≤ 0.56, p's ≥ .55.

A similar effect was observed when using the CAI as the dependent variable. The overall model with four predictors was significant, F (4, 163) = 5.27, p= .001, R^2= .12. Examination of the individual contribution of predictors indicated that this effect was again largely driven by change in negative affect. Specifically, when holding the other predictors constant, change in DASS scores predicted change in CAI scores, β = .24, t = 3.17, p = .002. Change in QSU-B relief scores was a marginally significant predictor, β = .25, t = 1.74, p = .08. However, change in QSU-B desire and average cigarettes per day did not predict change in the more extreme beliefs measured by the CAI, |β's| ≤ .09, |t's| ≤ 0.63, p's ≥ .45.

Table 10

Correlations Between Residualized Change Scores

	Desire to Smoke (QSU-B-D)	Need for Relief (QSU-B-R)	Amount smoking	Negative Affect (DASS)
ACQ	.08	.11	.02	**.24**
CAI	.14	**.21**	-.06	**.29**

Note: All variables are residualized change scores. ACQ = Appraisals of Craving Questionnaire. CAI = Catastrophic Appraisals Index (CAI). N=168. $r_{95\%crit.}$ = .15.

5.3.3.4 Experimental Effects on Withdrawal, Cravings, Negative Affect

5.3.3.4.1 Review of Hypotheses

Turning now to the alternative directional pathway, the metacognitive model suggests that appraisals of cravings affect negative affect (DASS), urges to smoke (QSU-B) and other symptoms of withdrawal (irritability, sleeplessness, hunger, etc.; MNWS). If so, individuals in

the MC condition (by virtue of decreased appraisals) should report fewer of these symptoms than the control conditions. Smoking cessation is also expected to increase symptoms of withdrawal, craving and negative affect. Thus, an interaction effect may occur, whereby withdrawal is more severe among people who quit smoking and who do not receive metacognitive psychoeducation.

5.3.3.4.2 ANCOVAs

Four 2 (cessation date) x 3 (psychoeducation condition) ANOVAs examined experimental effects on indicators of cessation difficulty; T1 scores were included as covariates when available (i.e., for all analyses but the MNWS).

When T2 QSU-B-desire scores were used as the dependent variable, analyses showed a significant main effect of cessation condition, F (1, 164) = 6.23, p =.01, η^2 = .04, such that individuals attempting to quit smoking reported significantly *lower* desire to smoke. The main effect of psychoeducation condition was not significant, F (2, 164) = 0.783, p =.46, η^2 =.009, nor was the interaction between cessation and psychoeducation conditions, F (2, 164) = 1.23, p =.30, η^2 = .01.

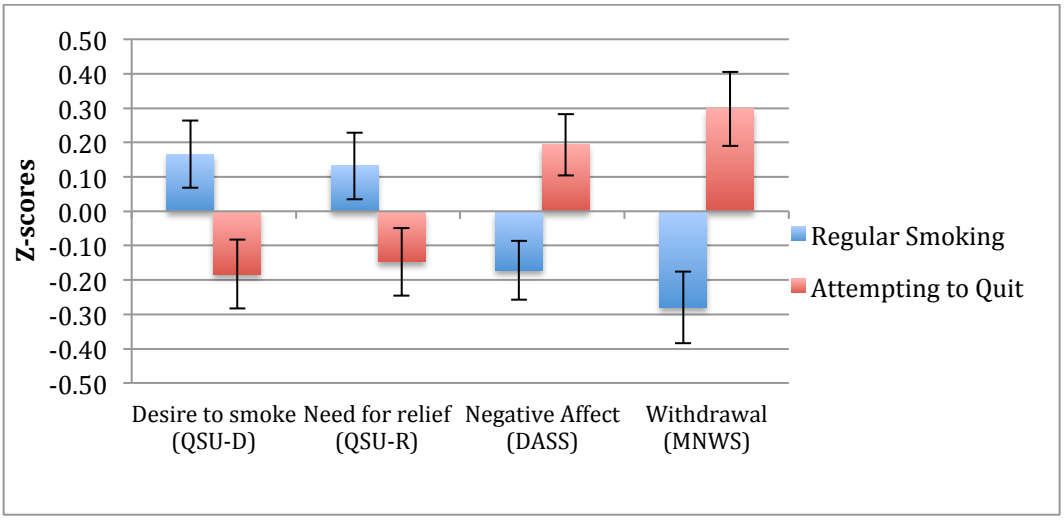
T2 QSU-B-relief scores showed a similar pattern. Analyses showed a significant main effect of cessation condition, F (1, 164) = 3.97, p =.05, η^2 = .02, such that individuals attempting to quit smoking reported significantly *lower* urge to smoke to relieve negative affect at T2. The main effect of psychoeducation condition was not significant, F (2, 164) = 0.728, p =.46, η^2 =.009, nor was the interaction between cessation and psychoeducation conditions, F (2, 164) = 0.68, p =.51, η^2 = .008.

T2 DASS scores also showed a significant main effect of cessation condition, F (1, 161) = 8.73, p =.004, η^2 = .05, but this time individuals attempting to quit smoking reported significantly *higher* negative affect at T2. The main effect of psychoeducation condition was not significant, F (2, 161) = 0.36, p =.70, η^2 =.004, nor was the interaction between cessation and

psychoeducation conditions, F (2, 161) = 0.09, p =.92, η^2 = .001.

T2 MNWS scores also showed a significant main effect of cessation condition, F (1, 164) = 14.94, p <.001, η^2 = .08, such that individuals attempting to quit smoking reported significantly *more* withdrawal symptoms at T2. The main effect of psychoeducation condition was not significant, F (2, 164) = 0.10, p =.91, η^2 =.001, nor was the interaction between cessation and psychoeducation conditions, F (2, 164) = 0.35, p =.70, η^2 = .004. Figure 7 displays T2 craving, negative affect and withdrawal across cessation groups.

Figure 7. T2 Craving, Negative Affect and Withdrawal



Note: Bars represent standardized means at T2 (adjusted for T1 for all measures except the MNWS). QSU-B = Questionnaire of Smoking Urges, DASS = Depression, Anxiety and Stress Scale, MNWS = Minnesota Nicotine Withdrawal Scale. N = 176

5.3.3.5 Does Change in Beliefs Predict Change in Smoking-Related Variables?

Overall, this suggests that while the metacognition condition generally reduced maladaptive appraisals, it did not have the predicted impact on negative affect and urge to smoke at T2. One possibility is that this occurred because the psychoeducation manipulation effect size was not large enough. In addition, it is possible that the manipulation did not target the "right" kind of appraisals—specifically, metacognitive psychoeducation produced declines in the ACQ over the four-day period, but did not affect CAI scores at T2. To the extent that the CAI

is central to the picture, the psychoeducation manipulation may not have provided an adequate test of the impact of metacognitive beliefs on cravings, withdrawal and negative affect.

To shed some light onto these possibilities, a series of regression analyses examined whether the residualized change scores of metacognitive beliefs as measured by the ACQ and CAI predicted residualized change in craving (QSU-B subscales), negative affect (DASS) and T2 nicotine withdrawal (MNWS). The ACQ and CAI were entered together in the first step of the model in order to assess the unique contribution of each type of metacognitive belief. Results of these analyses are shown in Table 11. Across all of the analyses, change in metacognitive beliefs was a significant predictor of change in negative affect, symptoms of withdrawal and urge to smoke for relief. Interestingly, examination of the individual predictors suggests that this effect was largely driven by the CAI. Change in the more extreme appraisals assessed by the CAI explained a small but significant proportion of variance in all three variables. However, when CAI scores were included in the model, the ACQ did not explain any additional variance in the outcome variables. Change in metacognitive beliefs did not predict change in QSU-B desire or average self-reported cigarettes per day.

Table 11

Prediction of T2 Smoking Outcomes

	ACQ			CAI			Overall Model		
Outcome Variable	*β*	*t*	*p*	*β*	*t*	*p*	*F*	*p*	*R*
QSU-B-Desire	.02	.26	.79	.13	1.49	.14	1.61	.20	.14
QSU-B-Relief	.03	.29	.77	**.20**	**2.41**	**.02**	**3.96**	**.02**	**.21**
Negative Affect (DASS)	.14	1.66	.10	**.23**	**2.87**	**.005**	**9.19**	**<.001**	**.32**
Withdrawal (MNWS)	.13	1.62	.11	**.16**	**1.94**	**.05**	**5.53**	**.005**	**.25**
Self-reported smoking	.05	.55	.58	.07	.87	.38	.40	.67	.07

Note: All variables are residualized change scores, with the exception of the MNWS. N=169. $r_{95\%\text{crit.}}$ = .15

Experimental and non-experimental results were not moderated by gender, ethnicity, employment status, duration of smoking, use of nicotine replacement aides, nicotine

dependence score or anxiety sensitivity. These potential moderators were tested by re-running analyses and including these variables as additional predictors in models. Nonsignificant interactions with primary predictors (i.e., metacognitive beliefs or smoking-related variables) were taken to indicate lack of moderation, all *p*'s <.05.

5.3.4 One-Month Follow-Up

78% of participants reported that they were smoking daily at the one-month follow-up. On average, participants reported that their attempt to quit smoking lasted 13.65 days (SD = 12.26) and that they were currently smoking 7.51 cigarettes per day (SD = 7.58). ANOVAs indicated that neither the psychoeducation nor cessation manipulation was a significant predictor of number of cigarettes smoked per day at the one-month follow-up (covarying out T1 smoking level) or self-reported duration of the cessation attempt, *F*'s (2, 152) ≤ 1.04, *p*'s ≥ .36, η^2 's ≤ .01. Similarly, examination of correlational relationships indicated that measures of metacognitive beliefs were not significantly related to one-month smoking outcomes, |*r*'s| ≤ .13, *p*'s ≥ .11.

5.4 Summary

Effects of Cessation on Metacognitive Beliefs. The cessation manipulation appeared successful. That is, analyses suggested that individuals assigned to quit smoking after the first lab session did so, as evidenced by lower self-reported smoking and expired CO levels at the second lab session. These individuals reported greater levels of withdrawal and negative affect but decreased levels of craving.

There were no effects of cessation condition on metacognitive beliefs, however, which implies that the relationship observed between metacognition and cessation difficulty is not directly caused by the initiation of a cessation attempt and corollaries (increased withdrawal, etc.). One possible reason this effect was not observed could be because it is theoretically contingent on cessation producing a consistent increase in craving, withdrawal and negative affect. However, some individuals in the cessation condition had relapsed by T2, thus potentially

returning their smoking, craving and negative affect to baseline levels. Analyses repeated with the cessation manipulation broken down based on cessation outcome (i.e., successful attempt vs. "failed" attempt vs. smoking regularly) supported this interpretation. These results suggested that individuals who had been successful in their quit attempt showed a significantly greater decline in ACQ scores than either of the other two groups. As another way to look at it, individuals who "failed" in their quit attempt endorsed significantly more maladaptive beliefs about cravings than those who were successful.

While causal directions are uncertain given the nonexperimental nature of these follow-up analyses, these results are nevertheless intriguing. It is possible that individuals who experience greater success in their cessation attempt essentially "learn" about their cravings. For example, by persisting through cravings without smoking, these individuals may come to understand that cravings are tolerable, that they do not mean anything negative about oneself or one's quit attempt. This interpretation complements research indicating that providing monetary incentives to smokers to "practice" quitting increases cessation-related self-confidence and the probability of later abstinence (Higgins, Badger, & Budney, 2000; Higgins et al., 2006). Similarly, unsuccessful quitters may "learn" more maladapative beliefs—smokers may notice that they have lapsed and/or are back to smoking regularly and attribute this their personal qualities (e.g., being "weak-willed", "out of control" or fundamentally unable to tolerate cravings) or the profoundly powerful nature of cravings. While in some respects this explanation paints metacognitive appraisals as an inconsequential corollary of failing a cessation attempt, this is not necessarily the case. Overinterpreting the meaning of cessation failure for personal strength or cessation ability may discourage smokers from trying again in the near future. It is also important to keep in mind the nonexperimental nature of these analyses. Specifically, it may be that variations in ways of thinking about cravings (e.g., tendency to accept and tolerate versus overinterpret) are partially responsible for the success of the attempt in the first place. This is consistent with both metacognitive models and recent work indicating that ability to

tolerate distress may meaningfully differentiate early smoking lapsers from longer term abstainers (Brown et al., 2009).

Regression analyses were conducted across groups to examine whether changes in cravings, withdrawal and negative affect were predictive of changes in metacognition. Results suggested that changes in beliefs are not directly related to changes in craving severity (as measured by the QSU-B-desires) or average number of cigarettes smoked per day. Rather, change in metacognitive beliefs appeared to relate to changes in negative affect and to a marginal extent, urges to smoke to relieve negative affect. This is consistent with mood-congruent information processing effects, whereby feeling more depressed, anxious and stressed increases self-focus, attention towards negative stimuli and personally-relevant attributions for failure (Forgas & Locke, 2005; Koster, De Raedt, Goeleven, Franck, & Crombez, 2005; Krohne, Pieper, Knoll, & Breimer, 2002). Thus, experiencing an increase negative affect could cause smokers to view their cravings as more negative, personally reflective and important to control. To the extent that "failed" quitters are the ones experiencing more negative affect and greater urges to smoke to relieve this distress, this could also explain why they demonstrate elevated appraisals at T2. These interpretations are congruent with models positing a central role for negative affect in the nicotine withdrawal process (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004). In fact, metacognitive beliefs may supplement negative reinforcement expectancies as a mechanism underlying the impact of distress on cessation relapse.

Effects of Psychoeducation on Smoking Variables. Maladaptive appraisals were reduced successfully by the metacognition psychoeducation, as indicated by lower post-presentation ACQ and CAI scores relative to the two control groups. While this reduction in appraisals was maintained over time for appraisals as measured by the ACQ scores, CAI scores at T2 did not differ between experimental conditions. Analyses suggested that contrary to the metacognitive model, MC psychoeducation did not produce appreciable changes in T2

distress, cravings or withdrawal severity. It is possible that this is because appraisals do not actually affect withdrawal and craving severity, or because the MC manipulation did not consistently affect the right kind or amount of change in metacognition. Indeed, the psychoeducation effect size was relatively small and not maintained over time for the CAI. To the extent that the types of extreme appraisals measured by the CAI are critical to the metacognitive cycle, analyses may not have been adequately sensitive to this effect.

Examination of non-experimental outcomes provided some support for these alternative interpretations. Specifically, across a series of regression analyses, change in the more extreme metacognitive beliefs assessed by the CAI was a significant predictor of change in negative affect, symptoms of withdrawal and urge to smoke for relief. However, when CAI scores were included in the model, the ACQ did not explain additional variance in these outcome variables. This suggests that of the ACQ and CAI, the CAI may better tap the types of appraisals potentially relevant to withdrawal processes. As such, a main effect of psychoeducation condition may not have been observed because the psychoeducation did not produce large or sustained change in the types of extreme, infrequently endorsed beliefs assessed by the CAI.

Change in metacognitive beliefs did not predict change in QSU-B desire, average self-reported cigarettes per day or one-month smoking outcomes. One possibility is that a relationship was not observed between metacognition and craving due to measurement issues. Items on the QSU-B refer to the present moment and seem to imply an element of intention, a willingness to act on the urge (e.g., 'I am going to smoke as soon as possible'). While research has shown that QSU-B scores are elevated after 24 hours of abstinence (West & Ussher, 2010), other work shows declines in the QSU-B among individuals attempting to quit smoking, particularly among successful abstainers (Cappelleri et al., 2007). It is possible that then, that individuals trying to quit may be experiencing frequent thoughts about smoking, but may nevertheless deny that they "would do anything for a cigarette right now" or that "nothing would

be better than a cigarette" if they are still committed to achieving abstinence. Use of a measure like the Obsessive Compulsive Smoking Scale (as in Nosen & Woody, 2009), which focuses on assessing the persistence, intensity and distress associated with thoughts about smoking, may better capture the intended construct.

Timing of measurement may also be pertinent. In the present study we assessed craving severity at T2, four days after the metacognitive psychoeducation. However, cravings fluctuate over the course of the day and tend to decline over the quit period (Shiffman, Engberg, et al., 1997). Thus, assessment of cravings at one single time point may not adequately capture the dynamics of cravings. Collins and Graghm (2002) note that because cause-effect relationships tend to decay over time, substantial lag between assessments in prospective studies can also lead researchers to miss important associations. Ecological momentary assessment (EMA), which involves repeated sampling of experiences in real time, have been recommended as a remedy to this problem (Shiffman, 2009; Shiffman, Stone, & Hufford, 2008). As such, the purpose of the following chapter is to investigate the impact of metacognitive psychoeducation on craving severity over the course of the first day of cessation.

Chapter 6: Longitudinal Outcomes: EMA Data

6.1 Introduction

Ecological momentary assessment (EMA), which involves repeated sampling of experiences in real time, has been emerging as an important measurement tool for understanding smoking cessation processes (Shiffman et al., 2008). Comparison of real-time with retrospective recall of smoking lapses indicates that people are relatively poor at remembering details of past smoking experiences (Shiffman, Hufford, et al., 1997). Thus, EMA has the advantage of eliminating retrospective memory biases. EMA methods also allow researchers to capture dynamic processes involved in cessation that may be overlooked by less temporally sensitive methods. Shiffman and colleagues (Shiffman, 2005), for example, showed that while day-to-day changes in negative affect do not predict cessation lapse, lapse episodes are typically preceded by escalations in negative mood. Thus, EMA methods are likely to be particularly well suited to understanding cravings, which have been shown to vary considerably over the course of a day, often in response to environmental cues and other situational contexts (Shiffman, Engberg, et al., 1997; Shiffman, Gnys, et al., 1996).

The purpose of the following chapter is to investigate the impact of metacognitive psychoeducation on craving severity over the course of the first day of cessation. While MC psychoeducation did not produce appreciable changes in cravings as assessed by the QSU-B at T2, this may be because more fine-grained analysis of cravings over time is required to capture effects. Understanding cravings during the first day of monitoring may be particularly important because elevations in urge to smoke during the first 24 hours of a cessation attempt (particularly after waking) have been shown to prospectively predict relapse among smokers attempting to quit (al'Absi, Hatsukami, Davis, & Wittmers, 2004; Shiffman, Engberg, et al., 1997). Metacognitive models predict that providing information discouraging appraisals of craving-related thoughts as personally meaningful and necessary to control will decrease severity of cravings during the first day of smoking cessation, relative to control conditions.

6.2 Method

6.2.1 Participants

Participants were the full sample of 176 English-speaking adult smokers interested in quitting. See Section 2.2 for full sample details.

6.2.2 Measures

6.2.2.1 EMA

Participants were provided with a pager and a pocket-sized coil-bound pad of paper with pre-printed questions; a small pen was attached to the paper pad. Participants completed a single-item Visual Analogue Scale (VAS) assessment of smoking urge ("How strong is your urge to smoke?") answered on a 50mm VAS scale anchored by "not at all" on the left, and "extremely" on the right. This wording is frequently used in studies assessing nicotine cravings via VAS (Dols et al., 2002; Dols et al., 2000; Lee et al., 2003). There appears to be no significant loss of precision or accuracy in VAS assessments considerably shorter than the traditional 10 cm lines (Kreindler et al., 2003). Participants also indicated how much they had smoked since the last form completion and completed a few additional questions not used in the present analyses (e.g., about mood, coping). Each form completion took approximately 1 minute. A reference page was included in each questionnaire booklet to provide researcher contact information and instructions on pager use (e.g., how to turn page to vibrate only) and what to do in the event of a mishap (e.g., if pager or question booklet left at home).

6.2.1 Procedures

Measures were administered as a part of the larger study protocol (see Section 2 for details). Briefly, after assessing study eligibility, participants were asked to select a date to quit smoking within the next two weeks and were then randomly assigned to a cessation condition. Individuals in the cessation attempt condition attended their first lab session (T1) on the day immediately before quitting, individuals in the anticipated cessation condition attended this session 8 days before their anticipated quit date. During this first lab session, participants were

randomly assigned to one of the three experimental psychoeducation conditions. In the *metacognition* condition, this presentation focused on the nature of cravings and thoughts about smoking, with the goal of reducing maladaptive appraisals and responses to craving-related thoughts, images and impulses. In the *psychoeducation control* condition, discussion focused on smoking risk factors and common cessation methods, with the goal of matching the metacognitive discussion's level of information, relevance to smoking cessation, experimenter attention, and participant involvement. This condition was not expected to produce any observable changes in measures of metacognition. However, talking to participants about cessation and encouraging use of effective coping were important to control for as they may incidentally potentially boost cessation self-efficacy and perhaps even success. The *no psychoeducation control* condition was intended as a second comparison group that does not provide these non-specific treatment effects. In this condition, participants did not receive any supplementary psychoeducation and instead spent time completing a few additional questionnaires. In total, the psychoeducational presentations took approximately 1 to 1.5 hours, depending upon the pace with which the participant completed the questions during the presentation.

Participants then received instruction in the in vivo, between-session measurement of smoking-related thought frequency, urge to smoke and mood state. Approximately 15 minutes were spent describing the procedures to participants, having them complete an example form and problem-solving potential difficulties with monitoring. Participants were encouraged to use their own cell phone as a signaling device instead of a pager when possible to ease participant burden and difficulties with novel technology. Even so, 72.7% opted to use a pager. Participants were instructed to temporarily turn the pager (or their cell-phone) to vibrate if they planned to be in a quiet location, to complete the form as soon as they remember (based on their current feelings) if they forgot to respond or missed a page and to immediately call the primary investigator's cell phone if they forget either the pager or monitoring paper at home. Participants

were asked to identify their projected hours of waking and sleeping over the next three days; pagers were programmed to signal at 8 random intervals within this time frame. To minimize initial reactivity, three pages were also sent to participants in the hours following the first lab session (data not included in analyses). To reduce inaccurate reporting, researchers instructed participants not to go back and complete missed forms. There was no penalty for uncompleted forms and payment was not contingent on form completion.

Sixteen individuals (9.1%) reported technical problems with the pager (e.g., battery died, weren't receiving pages for some reason, couldn't figure out how to work pager). As an alternative to not completing any monitoring, three individuals were instructed to simply complete monitoring forms approximately every 2 hours (8 per day). Including these individuals, participants completed an average of 7.33, 6.77 and 6.63 entries on days 1, 2 and 3, respectively. Overall compliance was calculated by dividing the total number of entries completed by 28 (the number of prompts). Of the 172 individuals who returned to complete the second lab session, 169 (98%) returned the monitoring booklet (either partially or fully completed). These participants completed an average of 25.5 forms (91% of prompts). This compliance rate is on par with (if not better than) rates seen in other studies employing short-term ecological momentary assessment involving smokers attempting to quit (Catley & Grobe, 2008; O'Connell et al., 1998; Rowan et al., 2007; Waters & Li, 2008). There were no differences between experimental conditions on compliance rates, η^2's < .008, *p*'s > .57.

All participants attended the second lab session (T2) 96 hours after the first session, when they completed a variety of measures not included in the present analyses and were debriefed.

6.2.2 Apparatus

6.2.2.1 Bedfont Scientific Ltd piCO+ Smokerlyzer

Bedfont Scientific Ltd. piCO+™ Smokerlyzer®. This carbon monoxide breathalyzer is a non-invasive, hand-held indicator of smoking status. See Section 2.4.1 for details.

6.2.2.2 Pagers

Rogers Sun Telecom Titan III Alphanumeric Pager. Participants were provided with an alphanumeric pager that signaled them to complete random in vivo assessments of cravings. Participants were instructed to keep the pager set to receive an auditory plus vibration alert unless the sound of a pager beep would be inappropriate (e.g., during a meeting or movie); in this case they could turn the pager to vibration only. Pages were scheduled and sent using NotePager Pro® computer software. Timing of the prompts was random within eight equally spaced segments of the waking hours specified by the participant. If a page was not read, the pager prompted the participant with a brief auditory signal every few minutes.

6.2.3 Analysis Overview

Metacognitive models predict that individuals receiving metacognitive psychoeducation will show relatively less severe cravings over the course of the day. Convergence between the EMA craving item and the QSU-B was first examined. Effects of the cessation and psychoeducation manipulation were then assessed with a 2 x 3 (cessation x psychoed) multilevel model examining change in the craving over the course of the first day. This analytical technique permits modeling of effects across time, takes into account the correlation between repeated measurements, is not affected by randomly missing data, and is robust when participants are measured at different time points (Gueorguieva & Krystal, 2004).

To ensure that forms represent an adequate sampling of a participant's time, only the 153 individuals who responded to at least 50% of prompts were included in analyses. Because inclusion of individuals continuing to smoke may occlude any potential differences in cravings between smokers and abstainers, analyses were also repeated using only those individuals "compliant" with cessation instructions (i.e., people who reported smoking or not smoking as per assignment). Analyses focused on cravings across days 2 and 3 of monitoring are not presented because the pattern of results were similar but the sample size was slightly smaller due to attrition.

6.3 Results

6.3.1 Checking Assumptions

All variables were examined for fit with the assumptions of multivariate analysis (normality, homoscedasticity of residuals, linearity). Visual inspection of individual growth trajectories indicated variation in rate and shape of trajectories: some were roughly linear, others were curvilinear. As such, several alternative models were examined for ideal fit (described below). No cases were identified as univariate (i.e., cravings at a single time point) or multivariate (i.e., cravings across time) outliers.

6.3.2 Convergent Validity of Craving VAS

Generally, EMA data in smoking studies do not correlate well (if at all) with questionnaire measures, most likely due to differences in temporal specificity and degree of reliance on retrospective recall. See Shiffman (2009) for review. Nevertheless, participants completed one EMA smoking urge VAS at the end of the first lab session, in close temporal proximity to the QSU-B and other questionnaires, to assess convergence with relevant measures.

The EMA smoking urge VAS completed at the end of the first lab session showed reasonable convergence with both the total scale QSU-B, $r = .54$, $p < .001$, and the subscales, QSU-B-desire $r = .40$, $p < .001$; QSU-B-relief $r = .48$, $p < .001$. Divergence from measures of other constructs was also apparent. The smoking urge VAS demonstrated small correlations with T1 negative affect, $r = .09$, $p = .26$, indicating good discriminant validity.

6.3.3 Growth Curve Modeling

Individual growth curve modeling (Singer, 1998) was used to analyze changes in urge to smoke over the course of the first day of monitoring. The multilevel model (using SAS PROC MIXED restricted maximum likelihood) permitted examination of how cravings changed over time (Level 1; within-person) as well as how this growth varied across experimental condition (Level 2; between-person).

After exploring several possible growth trajectory specifications (e.g., quadratic, cubic, logarithmic forms), a model including both linear and quadratic components appeared to provide the best fit based on minimal 2 log-likelihood (-2LL) and Akaike information criterion (AIC) statistics. Covariance structures allowing for autocorrelation (stronger relation between temporally closer observations than observations further apart in time) and heteroscedasticity (change in variability of responses over time) were explored but not implemented as they did not significantly improve model fit.

Level 1 model: $Urge_{it} = \pi_{0i} + \pi_{1i}TIME_{it} + \pi_{2i}TIME^2_{it} + \varepsilon_{it}$

In the Level 1 model, $Urge_{it}$ represents urge to smoke for participant *i* at time *t*. Time was centered at the self-reported time of waking on the first day of monitoring (i.e., the first day of cessation for some individuals). Thus, π_{0i} represents participant *i*'s true level of urge at the start of the first monitoring day (i.e., intercept) while π_{1i} represents participant *i*'s instantaneous rate of change in craving (i.e., linear slope) at waking, and π_{2i} represents participant *i*'s change in linear trajectory (i.e., acceleration/deceleration of craving strength) over time. The residual (ε) represents the proportion of urge to smoke at time *t* not explained by the passage of time.

The Level 2 (between-person) portion of the model uses the individual growth parameter from Level 1 as an outcome, allowing examination of whether experimental condition predicts variation in initial urge level, instantaneous linear slope or acceleration of change in craving over time. The intercept, linear and quadratic terms were allowed to vary freely.

Level 2 models:

$$\pi_{0i} = \beta_{00} + \beta_{01}[\text{Metacog vs. No Psychoed}] + \beta_{02}[\text{Reg vs. No Psychoed}] + \beta_{03}\text{Quit} + \beta_{04}\text{Quit}^*[\text{Metacog vs. No Psychoed}] + \beta_{05}\text{Quit}[\text{Reg vs. No Psychoed}] + u_{0i}$$

$$\pi_{1i} = \beta_{10} + \beta_{11}[\text{Metacog vs. No Psychoed}] + \beta_{12}[\text{Reg vs. No Psychoed}] + \beta_{13}\text{Quit} + \beta_{14}\text{Quit}^*[\text{Metacog vs. No Psychoed}] + \beta_{15}\text{Quit}[\text{Reg vs. No Psychoed}] + u_{1i}$$

$$\pi_{2i} = \beta_{20} + \beta_{21}[\text{Metacog vs. No Psychoed}] + \beta_{22}[\text{Reg vs. No Psychoed}] + \beta_{23}\text{Quit} + \beta_{24}\text{Quit}^*[\text{Metacog vs. No Psychoed}] + \beta_{25}\text{Quit}^*[\text{Reg vs. No Psychoed}] + u_{2i}$$

The Level 2 models include both cessation date (Quit) and psychoeducation condition (dummy coded, with individuals receiving no psychoeducation as the reference group) as predictors, along with their interactive effects. $\beta_{\cdot 0}$ thus represent Level 2 intercepts, or average true values for the π parameters in the Level 1 model at the start of the first full monitoring day for individuals who did not receive any psychoeducation and are not attempting to quit smoking. $\beta_{\cdot 1}$ are the Level 2 slopes comparing Level 1 intercept, instantaneous rate of change and acceleration values between individuals receiving no psychoeducation and those receiving metacognitive psychoeducation [Metacog vs. No Psychoed] among individuals not attempting to quit. $\beta_{\cdot 2}$ are the Level 2 slopes comparing Level 1 intercept, instantaneous rate of change and acceleration values between individuals receiving no psychoeducation and those receiving regular cessation psychoeducation [Reg vs. No Psychoed] among individuals not attempting to quit. $\beta_{\cdot 3}$ are the Level 2 slopes comparing parameters from the Level 1 model between individuals who were assigned to quit versus were smoking regularly (and did not receive psychoeducation). $\beta_{\cdot 4}$ and $\beta_{\cdot 5}$ respectively represent interactions between cessation attempt and the [Metacog vs. No Psychoed] and [Reg vs. No Psychoed] dummy variables and examine whether differences between psychoeducation conditions depends on whether individuals are attempting to quit smoking or not. $u_{\cdot i}$ are Level 2 residuals.

6.3.3.1 Experimental Effects on Day 1 Urge to Smoke

Identifying Covariates. Demographics and established predictors of cravings (measured at T1) were investigated for potential inclusion in the model to reduce error variance. Covariates were initially selected for inclusion if they predicted urge to smoke over time using a liberal $p < .15$ significance value.

Based on this criterion, predictors of urge to smoke over time included gender (females have stronger overall cravings), t (166) = -1.88, p =.05, years smoking (more years smoking predicts steeper decline in cravings), t (166) = -2.18, p =.03, employment status (employed people have steeper incline in cravings), t (166) = -2.56, p =.01, ethnicity (non-Caucasians have

stronger cravings), *t* (166) = -2.62, *p* =.01, cigarette dependence scale score (greater dependence predicts steeper decline in cravings), *t* (166) = -1.54, *p* =.12, longest period previously abstinent from smoking (longer abstinence predicts lower cravings), *t* (166) = -1.65, *p* =.10, expected benefits of smoking (SEQ-pos, greater perceived benefits predicts stronger cravings), *t* (166) = 2.14, *p* =.03, anxiety sensitivity (greater AS predicts stronger cravings), *t* (166) = 2.58, *p* =.01, T1 DASS (greater negative affect predicts stronger cravings), *t* (166) = 3.16, *p* <.001. Age was also a significant predictor of linear slope, *t* (166) = -2.05, *p* =.04, but was not included due to collinearity with years smoking (*r* = .84). Education level, cessation goal, average number of cigarettes smoked per day, T1 self-efficacy, impulsivity and expectations of the negative consequences of smoking (SEQ-neg) were not significant predictors of Day 1 craving, *t's* < 1.34*, p's* > .18.

Covariates were then all entered in prediction of the growth model. Only variables that remained significant predictors (based on *p* < .15) were retained as covariates in the final model, including gender, years smoking, employment status, ethnicity, anxiety sensitivity and T1 negative affect.

Model Building. Table 12 presents the results of model fitting. Model 1 represents the unconditional model. It does not take covariates into account and serves as a baseline for model comparison. The quadratic growth model (Model 2) takes both time and covariates into account. It provides an overview of how urges changed over time without accounting for experimental conditions. According to this model, the average participant (who is female, employed, non-Caucasian, been smoking for about 23 years and has average levels of negative affect and anxiety sensitivity) rated urge to smoke as 26.83 out of 50 upon waking up of the first monitoring day. At this point, urges levels increased by 0.7 points per minute (significant linear parameter). This rate of acceleration slowed by a non-significant 0.02 points per minute (quadratic parameter).

To examine the main research questions (i.e., how quit date and psychoeducation

affects urge to smoke), I next fit a model including experimental conditions and interactions with time as Level 2 predictors (Model 3). In Table 12, the reference group is individuals who are continuing to smoke (i.e., not quitting) and who did not receive any psychoeducation (with the same covariates mentioned above). This means that all coefficients presented in Table 12 are interpreted in relation to this group of individuals. For example, the intercept coefficient indicates that the average level of cravings for smokers not actively quitting (who are also women, employed, non-Caucasian, average in years smoking, anxiety and anxiety sensitivity and did not receive any psychoeducation) was 26.64 out of 50 upon waking on the first monitoring day. Urges in this condition remained relatively stable throughout the day, as indicated by the non-significant linear and quadratic parameters. This pattern is depicted in Figure 8 (blue solid line, graph of people receiving no psychoeducation).

Cravings over the course of the first day among continuing smokers receiving either regular or metacognitive psychoeducation are also depicted in Figure 8 (see solid green and red lines, respectively). The [Metacog vs. No Psychoed] and [Reg vs. No Psychoed] parameters in Table 12 and [Metacog vs. Reg Psychoed] in Table 13[3] (along with their linear and quadratic components) reflect the effects of the psychoeducation manipulation among participants who have not yet quit smoking. In other words, these parameters are statistical comparisons of the solid lines shown in Figure 8. Results suggest that among those continuing to smoke, there were no differences between the three psychoeducation conditions in either mean craving upon waking or in the linear or quadratic trajectory of cravings over the course of the day (see Tables 12 and 13, non-significant [Metacog vs. Reg Psychoed], [Metacog vs. No Psychoed], [Reg vs.

[3] Two tables are required to present all statistics due to use of dummy codes. The reference group in Table 12 is continuing smokers receiving no psychoeducation. The [Metacog vs. No Psychoed] and [Reg vs. No Psychoed] parameters describe how the metacognitive and regular psychoeducation groups differ from this reference group. Table 13 presents identical analyses but continuing smokers receiving metacognition serve as the reference group – this permits display of statistics for the third [Metacog vs. Reg Psychoed] between-group comparison.

No Psychoed] and time interactions), *p*'s > .31. Consistent with this, comparison of least square means at alternative time points indicated that cravings were not significantly higher among continuing smokers at other times during day 1 either, *p's* > .12. Thus, cravings among people continuing to smoke reached equivalent levels and followed a fairly similar trajectory over the day, regardless of whether or not they received psychoeducation (or what type).

Turning now to cravings among those quitting smoking, the dashed lines in Figure 8 show the course of cravings among people beginning their cessation attempt that morning. In Table 12, the Quit parameter (along with linear and quadratic components) compares continuing smokers who did not receive psychoeducation (the reference group) to people quitting smoking (in the same no psychoed condition). As illustrated in Figure 8 (first graph), cravings upon waking are 1.87 points higher among individuals quitting, but this effect is not significant. The linear and quadratic interactions with Quit are also not significant, indicating that the trajectory of cravings in individuals quitting versus continuing smoking is more or less parallel when they receive no cessation psychoeducation. Consistent with this, comparison of least square means at alternative time points indicated that cravings were also not significantly higher among quitters in this condition at other select time points during the day, *p's* > .09.

The Quit × [Metacog vs. Reg Psychoed], Quit × [Metacog vs. No Psychoed] and Quit × [Reg vs. No Psychoed] parameters (along with their linear and quadratic counterparts) compare psychoeducation condition effects on urge trajectories among the smokers attempting to quit –in other words, they represent statistical comparison of the three dashed lines shown in Figure 8. The Quit × [Reg vs. No Psychoed] parameters indicate that upon waking on the first monitoring day, urges are rated an average of 13.32 points lower among individuals who received regular psychoeducation, compared to those who did not receive any psychoeducation. The linear and quadratic trajectories are not statistically different, although there is a trend indicating that urges increased slightly faster after waking among those receiving regular psychoed (2.70 points per hour). Thus, comparisons of least square means indicate that receiving regular cessation

psychoeducation produces significantly lower cravings upon waking (compared to no psychoeducation), but this advantage disappears approximately 2.5 hours later as cravings continue to rise among this group.

The Quit × [Metacog vs. No Psychoed] and Quit × [Metacog vs. Reg Psychoed] parameters (in Table 12 and Table 13, respectively) compare the effects of receiving metacognitive psychoeducation to the control groups among people attempting to quit smoking. There is no difference between the metacognition and either control group in either craving levels upon waking (i.e., intercept), or in linear or quadratic trends, *p's* > .18. Accordingly, least square means of quitters receiving metacognitive psychoed are also not significantly different from control conditions later on in the day, *p*'s >.22.

To summarize, these results are not altogether consistent with metacognitive models, which suggest that metacognitive psychoeducation should ameliorate the effect of cessation on craving intensity. In fact, it was individuals receiving regular psychoeducation that experienced lower cravings immediately after waking when compared to those receiving no psychoeducation. The metacognitive psychoed instead produced craving intercepts and trajectories similar to both the control conditions.

6.3.3.2 Non-Experimental Effects on Day 1 Urge to Smoke

It could be argued, however, that the model including the full sample of participants does not represent an optimal test of the effects of the manipulation because the "quitting" group was often unsuccessful in this endeavor. That is, among the individuals attempting to quit smoking, only 45% (*n* = 38) reportedly made it through the entire day without smoking a single cigarette. This could potentially obscure the effects of psychoeducation on cravings among an abstinent sample. As such, analyses were re-run using only those individuals fully "compliant" with the cessation manipulation, based on self-reported absence of smoking during day 1 (*N* = 122).

Statistics for models run on this subsample are presented in Tables 12 and 13 (Model 4). Note that model fit indices are not directly comparable to the previous models given the

differences in sample size. Plots of urge trajectories over the course of the day within this subsample are presented in Figure 9, broken down by experimental condition.

Because the sample for individuals who are not attempting to quit is essentially the same (i.e., most smokers were successful in continuing to smoke), analyses for this subgroup paint the same picture. That is, cravings are relatively consistent over the course of the day and similar across psychoeducation conditions (see non-significant [Metacog vs. No Psychoed], [Metacog vs. Reg Psychoed], and [Reg vs. No Psychoed] parameters in model 4). Comparison of least square means between the three psychoeducation conditions indicated that there were no significant differences in craving levels at alternative time points across the day, *p*'s >.14.

Among individuals attempting to quit, however, analyses involving only those individuals who successfully abstained throughout the day appeared to accentuate differences between psychoeducation conditions. Towards understanding cessation effects in the reference condition (individuals who did not receive psychoeducation), abstaining from smoking produced marginally higher cravings upon waking (see Quit parameter), $p = .09$. Cravings in this group tended to follow a "U-shaped" quadratic trajectory, such that cravings were slightly higher in the morning and evening – however, the linear and quadratic trends were not statistically significant.

The intercepts and trajectories of cravings among abstainers receiving psychoeducation were significantly different. Abstainers who received either regular or metacognitive psychoed began the day with craving levels approximately 20 points below those receiving no psychoed (see Quit × [Metacog vs. No Psychoed] and Quit × [Metacog vs. No Psychoed] parameters). Both linear and quadratic trends also differed significantly. Cravings among abstainers who received either regular or metacognitive psychoeducation followed a steep linear pattern, such that the cravings (which began much lower) rose about 5 points faster per hour (see Quit × Time × [Metacog vs. No Psychoed] and Quit × Time × [Metacog vs. No Psychoed] parameters), *p*'s <.02. Thus, cravings in all groups were statistically equivalent approximately 2 hours after waking. Acceleration of cravings (i.e., quadratic trend) among abstainers receiving no psychoed

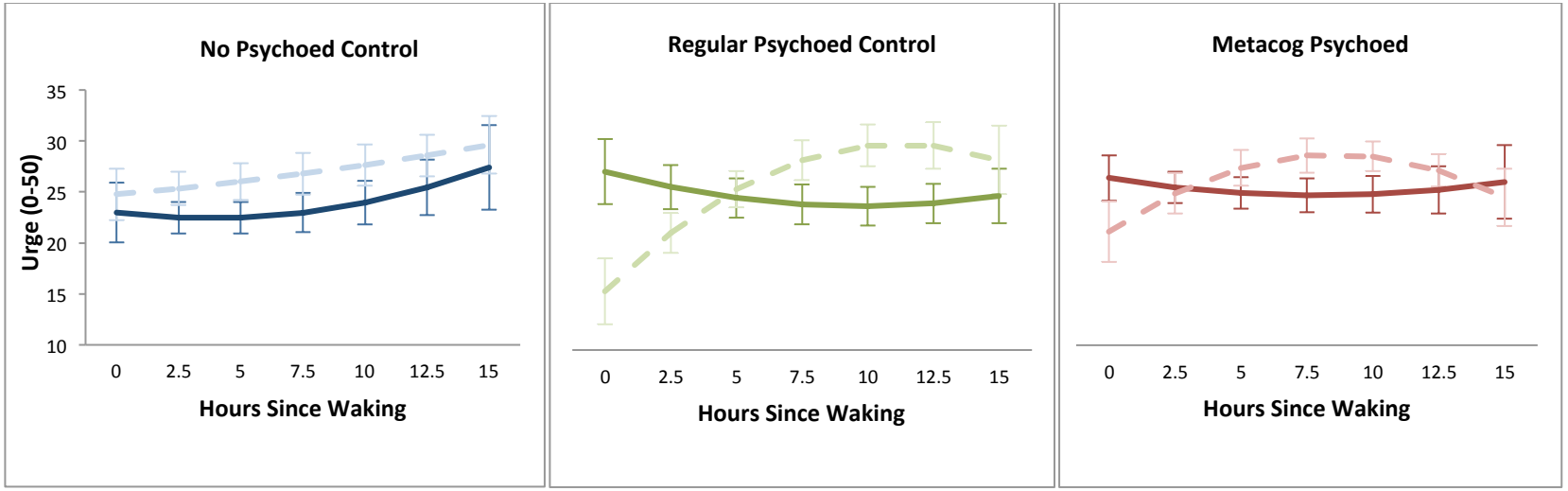
was significantly different from those receiving metacognitive psychoed and marginally different from those receiving regular psychoed (see Table 9, Quit $\times$ Time^2 $\times$ [Metacog vs. No Psychoed] and Quit $\times$ Time^2$\times$ [Reg vs. No Psychoed] parameters). This means that the rate with which cravings increased over the course of the day among individuals receiving psychoeducation slowed. Thus, for those receiving regular psychoeducation, cravings followed a fairly linear trend that began to level out later in the day, after about 12 hours awake. Least square means were accordingly similar in the control conditions following the first couple hours of waking. Cravings slowed even faster for those in the metacognitive condition, producing an inverse U-shape (see Figure 9). Cravings in these individuals not only leveled out sooner but also began to fall after about 10 hours awake. This conferred an advantage to abstainers in the metacognitive condition later in the day, such that least square means were lower than the no psychoeducation group after approximately 12.5 hours waking and also lower than the regular psychoeducation group after approximately 10 hours waking.

To summarize then, analysis of cravings over the course of the first monitoring day suggest that among people successfully abstaining from cigarettes, both regular and metacognitive psychoeducation produced significantly lower cravings earlier in the day than no psychoeducation. However, the metacognitive condition conferred a relative advantage later in day—while cravings continued to rise for individuals receiving regular or no psychoeducation, cravings plateaued and even began to drop later in the day for those receiving metacognitive psychoed. In fact, unlike the other two conditions, cravings for quitters receiving metacognitive psychoeducation were actually lower at several time points than cravings among those not attempting to quit.

Neither experimental nor non-experimental results were moderated by gender, ethnicity, employment status, duration smoking, use of nicotine replacement aides, nicotine dependence level or T1 negative affect. These potential moderators were tested by re-running analyses and including these variables as additional predictors in models. Nonsignificant interactions with key

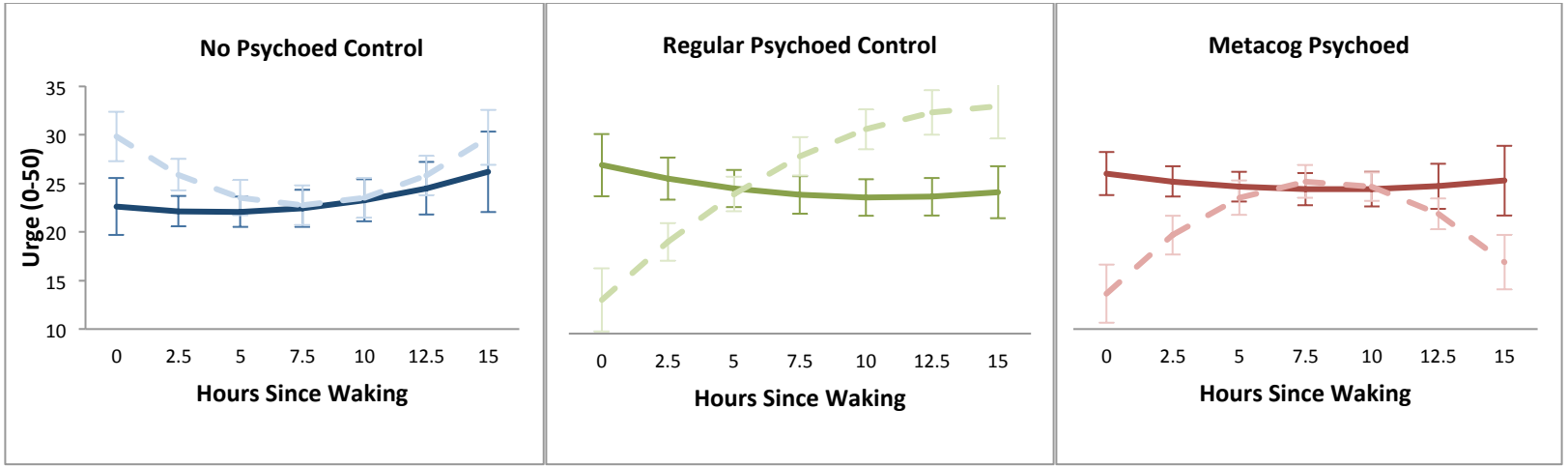
predictors (i.e., metacognitive beliefs or smoking-related variables) were taken to indicate lack of moderation, all *p*'s <.05.

Figure 8. Day 1 Urges to Smoke by Experimental Conditions, Full Sample



Note: Urge values are least-square means after multi-level model fitting and include covariates (gender, ethnicity, employment status, years smoking, anxiety sensitivity, and negative affect). Error bars reflect standard error. Dashed lines represent individuals quitting smoking; solid lines represent individuals continuing to smoke. *N* = 167.

Figure 9. Day 1 Urges to Smoke by Experimental Conditions, Compliant Subsample



Note: Urge values are least-square means after multi-level model fitting and include covariates (gender, ethnicity, employment status, years smoking, anxiety sensitivity, and negative affect). Error bars reflect standard error. Dashed lines represent individuals quitting smoking who reported no smoking on day 1; solid lines represent individuals continuing to smoke. *N* = 122.

Table 12

Estimates for Day 1 Urges to Smoke

Parameter	Model 1 (*N* = 167)			Model 2 (*N* = 167)			Model 3 (*N* = 167)			Model 4 (*N* =122)		
	Est.	*SE*	*p*	Est.	*SE*	*p*	Est.	*SE*	*p*	Est.	*SE*	*p*
						Fixed effects						
Intercept	24.02	0.67	<.001	26.83	2.19	<.001	26.64	3.55	<.001	25.16	3.63	<.001
Time				0.70	0.35	.04	-0.14	0.94	.88	-0.96	0.94	.92
Time^2				-0.02	0.02	.38	0.04	0.06	.51	0.04	0.06	.51
Quit							1.78	3.82	.64	7.20	4.18	.09
Quit×Time							0.51	1.22	.68	-1.72	1.50	.25
Quit×Time^2							-0.03	0.07	.68	0.10	0.09	.27
[Metacog vs. No Psychoed]							3.41	3.56	.34	3.41	3.48	.33
[Reg vs. No Psychoed]							4.19	4.14	.31	4.41	4.09	.28
[Metacog vs. No Psychoed] × Time							-0.13	1.11	.91	-0.11	1.11	.92
[Reg vs. No Psychoed]× Time							-0.39	1.19	.74	-0.35	1.19	.77
[Metacog vs. No Psychoed] × Time^2							-0.01	0.08	.87	-0.01	0.07	.85
[Reg vs. No Psychoed]× Time^2							-0.004	0.08	.96	-0.07	0.08	.92
Quit × [Metacog vs. No Psychoed]							-7.05	5.23	.18	-19.58	6.11	.002
Quit × [Reg vs. No Psychoed]							-13.32	5.74	.02	-20.82	6.03	.001
Quit × [Metacog vs. No Psychoed] × Time							1.68	1.58	.29	5.19	2.14	.02
Quit × [Reg vs. No Psychoed]× Time							2.70	1.67	.11	5.11	2.01	.01
Quit × [Metacog vs. No Psychoed] × Time^2							-0.09	0.10	.35	-0.33	0.14	.02
Quit × [Reg vs. No Psychoed] × Time^2							-0.11	0.11	.28	-0.23	0.12	.07
						Random effects						
Intercept	58.85	8.30	<.001	101.29	25.08	<.001	90.58	24.30	<.001	59.24	25.56	.01
Time				6.52	2.13	.001	5.29	2.05	.004	4.42	2.40	.03
Time^2				0.02	0.008	.005	0.02	0.01	.01	0.02	0.01	.04
						Goodness of fit						
-2LL		10142.7			10000.8			9984.2			NA	
AIC		10146.7			10014.8			9998.2			NA	

Note. Participants who did not receive psychoeducation and are continuing to smoke (i.e., not quitting) are the reference group. Quit = Cessation vs. continuing smoking conditions. [Metacog vs. No Psychoed] = metacognitive psychoeducation vs. no psychoeducation dummy code; [Reg vs. No Psychoed] = regular cessation psychoeducation vs. no psychoeducation dummy code; -2LL = -2 log-likelihood; AIC = Akaike information criterion. Covariates (gender, ethnicity, employment status, years smoking, anxiety sensitivity, negative affect) are included in models 2 through 4.

Table 13 Estimates for Day 1 Urges to Smoke (alt reference group)

Parameter	Model 3.1 (*N* = 167)			Model 4.1 (*N* =122)		
	Est.	*SE*	*p*	Est.	*SE*	*p*
			Fixed effects			
Intercept	30.05	2.84	<.001	28.56	2.95	<.001
Time	-0.27	0.63	.67	-0.20	0.62	.74
Time^2	0.03	0.04	.55	0.03	0.62	.56
Quit	-5.26	3.68	.16	-12.38	4.51	.007
Quit×Time	2.20	0.99	.03	3.48	1.52	.02
Quit×Time^2	-0.13	0.07	.05	-0.23	0.11	.04
[Metacog vs. Reg Psychoed]	0.79	3.74	.83	1.00	3.69	.79
[Metacog vs. No Psychoed]	-3.41	3.56	.34	-3.41	3.48	.33
[Metacog vs. Reg Psychoed] × Time	-0.26	0.97	.79	-0.25	0.98	.80
[Metacog vs. No Psychoed] × Time	0.13	1.11	.91	0.11	1.11	.92
[Metacog vs. Reg Psychoed] × Time^2	0.008	0.06	.90	0.007	0.06	.90
[Metacog vs. No Psychoed] × Time^2	0.01	0.07	.87	0.01	0.07	.85
Quit × [Metacog vs. Reg Psychoed]	-6.26	5.60	.26	-1.23	6.30	.85
Quit × [Metacog vs. No Psychoed]	7.05	5.28	.18	19.58	6.11	.001
Quit × [Metacog vs. Reg Psychoed] × Time	1.02	1.52	.50	-0.08	2.03	.97
Quit × [Metacog vs. No Psychoed] × Time	-1.68	1.58	.29	-5.19	2.14	.02
Quit × [Metacog vs. Reg Psychoed] × Time^2	-0.02	0.10	.86	0.10	0.14	.47
Quit × [Metacog vs. No Psychoed] × Time^2	0.10	0.10	.35	0.33	0.14	.02
			Random effects			
Intercept	90.58	24.30	<.001	59.24	25.56	.01
Time	5.29	2.05	.004	4.42	2.40	.03
Time^2	0.02	0.01	.01	0.02	0.01	.04
			Goodness of fit			
-2LL		9984.2			NA	
AIC		9998.2			NA	

Note. Participants who received metacognitive psychoeducation and are continuing to smoke (i.e., not quitting) are the reference group. Quit = Cessation vs. continuing smoking conditions. [Metacog vs. Reg Psychoed] = metacognitive psychoeducation vs. regular cessation psychoeducation dummy code; [Metacog vs. No Psychoed] = metacognitive psychoeducation vs. no cessation psychoeducation dummy code; -2LL = -2 log-likelihood; AIC = Akaike information criterion. Covariates (gender, ethnicity, employment status, years smoking, anxiety sensitivity, negative affect) are included in models 2 through 4.

6.4 Summary

Elevations in urges to smoke during the first 24 hours of a cessation attempt, particularly cravings occurring shortly after waking, prospectively predict relapse among smokers attempting to quit (al'Absi et al., 2004; Shiffman, Engberg, et al., 1997). In the present study, analysis of cravings over the course of the first monitoring day suggest that

both regular and metacognitive psychoeducation produced significantly lower cravings earlier in the day than no psychoeducation, but only among people successfully abstaining from cigarettes.

Intriguingly, the metacognitive condition also conferred a relative advantage later in day—while cravings continued to rise for abstaining individuals receiving regular or no psychoeducation, cravings plateaued and even began to drop later in the day for those receiving metacognitive psychoeducation. These effects are consistent with metacognitive models, which suggest that acceptance and tolerance-based approaches to cravings may reduce unhelpful over-reactions to cravings and therefore prevent unnecessary exacerbations in cravings. This suggests that longitudinal and/or more temporally fine-grained analyses may be necessary to observe the effects of metacognitive beliefs on craving severity.

It is important to note, however, that causality cannot be inferred given that effects only occurred in a small subsample that was not randomly allocated. There may have been something particular about the abstainers that produced the observed experimental effects on cravings. For example, perhaps it was only individuals whose cravings are naturally lower in the morning/evening or people whose urges ameliorate faster that managed to abstain for the entire day after receiving metacognitive psychoeducation. Metacognitive psychoeducation could have been less effective for some individuals whose cravings naturally followed different patterns (but who were excluded from analyses of abstainers).

A few limitations related to the experience sampling data collection are also important to note. First, although periods between EMAs were brief, it is still possible that retrospective recall biased self-reported smoking. For example, Shiffman (2009) notes that even brief recall periods may confound mood with smoking recall, such that people recall smoking more when stressed. As well, because EMA measures were paper based, it is possible that some participants were selective about when they recorded their data. That is,

some may have responded to pages immediately, while others may have delayed responding. This may have inadvertently introduced bias (e.g., participants may have been more likely to respond promptly when cravings were severe or alternatively may have waited until cravings were not severe). Indeed, concern has been raised about compliance with paper-and-pencil format diaries, which, unlike electronic handheld devices, do not permit reliable data-entry time stamping and are accordingly vulnerable to back filling. Several studies (e.g., Broderick, Schwartz, Shiffman, Hufford & Stone, 2003; Stone, Shiffman, Schwartz, Broderick & Hufford, 2002) have compared participant self-reported paper diary completion times following prompts with actual completion times using a covert device that records the time that the diary is opened and closed. They found that while participants' self-reported compliance (i.e., filling out a diary entry with what appeared to be an appropriate date/time label) ranged from 84.6% to 90.5%, verified compliance (i.e., opening the electronic diary at the appropriate date/time) only occurred for 29.1% to 38.6% of entries. This suggests that a significant proportion of participants may falsify the timing of diary records, which raises doubts about the trustworthiness of paper-based EMA data.

More recent evidence indicates that concerns about compliance with paper diaries may be slightly overstated. Green, Rafaeli, Bolger, Shrout and Reis (2006), for example, found paper and electronic diaries produced similar compliance rates, psychometric properties and patterns of findings. Researchers have also noted that factors like motivation and degree of participant burden likely affect compliance rates substantially (Tennen, Affleck, Coyne, Larsen & Delongis, 2006). In the present study, several design elements were implemented to minimize this issue. For example, participants were not paid for their compliance, thus eliminating financial incentive for invalid entries. The monitoring period was also relatively brief (three days versus three weeks in Broderick et al., 2002), which likely reduced motivation to back fill forms out of fatigue or irritation; this may be particularly true

for data obtained during the first day of monitoring. Efforts were also made to ensure participants understood the importance of not falsifying missed entries. Statistically, any bias present due to backfilling is expected to increase error variance, but to a similar extent across experimental groups. Thus, compliance issues may have made it more difficult to detect significant between-group differences. Overall, replication with electronic diary monitoring would increase confidence in results.

Some researchers also advocate for collecting user initiated EMA data (e.g., at moments of smoking or particularly strong urges) in addition to random assessments in order to get the most temporally relevant model of real-time smoking behaviour (Shiffman, 2009). In the present study, the primary interest was in modeling craving over time (not lapses or smoking behaviour per se). Thus, I opted not to include user-initiated EMAs out of concern for increasing participant burden (particularly among those smoking regularly) and introducing new sources of reporting variability (e.g., subjective interpretations of "how strong" an urge needs to be to require reporting). As such, it is likely that some participants experienced intense craving episodes at times that were not captured by random assessment. This may introduce unexplained variability in correlations between relevant constructs (e.g., metacognition may actually appear more strongly correlated with cravings if all intense urge episodes were "caught").

Chapter 7: Thought Suppression, Rumination and Urge to Smoke

According to metacognitive models, personally meaningful interpretations of unwanted thoughts are distressing and likely to elicit maladaptive coping responses such as thought suppression (i.e., actively trying not to think about a certain topic) and rumination (i.e., thoughts and behaviours that fixate attention on the presence and meaning of symptoms; (Nolen-Hoeksema, 1991; Rachman, 1997, 1998; Salkovskis, 1985; Wells, 2000) Thought suppression and rumination are hypothesized to increase self-focused attention, increase the accessibility of negative information about the self and prevent change in maladaptive metacognitive beliefs (Nolen-Hoeksema, 1991; Wells, 2000). In theory, suppression and rumination also have idiosyncratic effects that contribute to problems. Attempting to avoid the discomfort associated with unwanted thoughts by suppressing them can paradoxically make the thoughts recur with greater frequency (Abramowitz et al., 2001; Wegner et al., 1987). Rumination is posited to exacerbate and prolong distress, increase the probability of negative interpretations of stimuli and situations, and impede instrumental problem solving (Nolen-Hoeksema, 1987, 1991).

Correlational studies of real time self-reported coping during smoking cessation generally indicate that cognitive coping strategies are common and efficacious responses to smoking urges, with very few differences observed between specific strategies (Bliss et al., 1989; Ortendahl & Nasman, 2007; Shiffman, 1984b; Shiffman, Gnys, et al., 1996). Among the few exceptions to this rule, Shiffman (1984b) found that punitive self-talk (as previously discussed) and “willpower” were less effective than other cognitive and behavioural coping strategies. Very little research has studied the relationship between worry, rumination and punishment and cravings during smoking cessation.

Investigations of the role of thought suppression in addictive behaviours are more prevalent but have produced unclear results, with some studies finding that suppression of urges increases frequency of subsequent substance related thoughts or smoking behaviour

(Erskine, Georgiou, & Kvavilashvili, 2010; Palfai, Colby, et al., 1997; Palfai, Monti, et al., 1997; Salkovskis & Reynolds, 1994) and others failing to find an effect (Erskine et al., 2011; Reynolds et al., 2005; Rogojanski et al., 2011a). Correlational studies are also mixed. Some find a relationship between tendency to suppress thoughts (typically measured with the White Bear Suppression Inventory) and smoking behaviour (Toll et al., 2001), while others do not (Haaga & Allison, 1994; Nosen & Woody, 2009).

Measurement of thought suppression in substance users limits existing work. How does White Bear suppression relate to distraction, worry, punishment and other responses to unwanted thoughts? To what extent are cravings related to suppression of *smoking*-related thoughts, as opposed to avoidance of other kinds of intrusive thought? In addition to these measurement issues, no studies have investigated thought suppression in the context of smoking cessation, despite the fact that this is the time when suppression is likely implemented most naturally. It is also when suppression is likely to be most difficult, given the impact of nicotine withdrawal and negative affect on concentration (Piper & Curtin, 2006; Wenzlaff et al., 1988). Overall then, it is not clear how normative thought suppression is during a cessation attempt, nor is it known how natural use of suppression relates to cessation success.

The final aim of the present study is to examine the veracity of claims that thought suppression, punishment and rumination are problematic response styles that increase the persistence of unwanted thoughts. To the extent that this is true, maladaptive response styles were expected to share significant common variance, to correlate with indices of cessation difficulty (e.g., distress, withdrawal, craving) and to be used more frequently by unsuccessful quitters.

In the present study, earlier analysis (see Section 3) demonstrated moderate to large correlations between measures of metacognitive beliefs and punishment, worry and rumination and metacognitive beliefs. That is, people who believe that cravings are a

negative reflection on oneself (e.g., “I’m weak”) or one’s quit attempt (e.g., “I’m destined to fail”), and who believe that worry is potentially dangerous and important to control, tended to respond to cravings with more punishment, worry and rumination. Suppression, however, only correlated with beliefs tapping need for control of thoughts (MCQ-nc and ACQ), only among individuals unsuccessfully attempting to quit. As this suggests that some kind of process distinct from punishment, worry and rumination may be occurring with regards to thought suppression, the present chapter will first take a closer look at the interrelationships between thought suppression and other forms of metacognitive responses. One way to approach this question is to use factor analysis, which seeks to identify shared patterns of variance underlying the coping strategies. If suppression of craving-related thoughts is a problematic strategy, one might expect it to share significant common variance with other theoretically detrimental strategies like punishment, worry and rumination. If thought suppression is a more normative, potentially helpful coping strategy, it may instead covary with strategies like distraction, social coping and re-appraisal.

Second, analyses will examine how suppression, rumination and other metacognitive responses relate to cessation-related variables and whether there are differences in frequency of use by individuals smoking regularly and those attempting cessation. To the extent that thought suppression, worry, punishment and rumination are problematic response styles that increase the persistence of unwanted thoughts, they are expected to correlate with craving severity, withdrawal and distress, and to be used more frequently by individuals who are unsuccessful in their attempt to quit smoking.

7.1 Method

7.1.1 Participants

Participants were the full sample of 176 English-speaking adult smokers interested in quitting. See Section 2.2 for full sample details.

7.1.2 Measures

7.1.2.1 Metacognitive Responses

White Bear Suppression Inventory-Smoking (WBSI; Wegner & Zanakos, 1994). The WBSI is a 15-item self-report questionnaire that measures individuals' tendency to suppress intrusive smoking-related thoughts. See Section 2.3.4 for measure details.

Thought Control Questionnaire (TCQ; Wells & Davies, 1994). The TCQ is a 30-item self-report measure designed to assess use of worry, punishment, distraction, reappraisal and social strategies for controlling smoking and craving-related thoughts over the between-session monitoring. See Section 2.3.5 for measure details.

The Ruminative Response Scale-Brief Version (RRS; Nolen-Hoeksema & Morrow, 1991; Treynor et al., 2003) assesses the extent to which people respond to sadness or depressed mood by focusing on self, symptoms, and the causes and consequences of their mood. See Section 2.3.3 for measure details.

7.1.2.2 Negative Affect, Craving and Withdrawal

The *Depression Anxiety and Stress Scale* (DASS; Lovibond & Lovibond, 1995) is a 21-item scale assessing depression, anxiety and stress as described by the tripartite model of affect (Clark & Watson, 1991). See Section 2.3.7 for measure details.

The *Questionnaire of Smoking Urges-Brief* (QSU-B; Cox et al., 2001) assesses two aspects of craving severity: "a desire and intention to smoke with smoking perceived as rewarding," and "an anticipation of relief from negative affect with an urgent desire to smoke". See Section 2.3.8 for measure details.

The *Minnesota Nicotine Withdrawal Scale* (MNWS; Hughes & Hatsukami, 1986) measures the experience of eight common nicotine withdrawal symptoms. See Section 2.3.9 for details.

7.1.3 Procedures

Measures were administered as a part of the larger study protocol (see Section 2 for details). Briefly, after assessing study eligibility, participants were asked to select a date to quit smoking within the next two weeks and were then randomly assigned to a cessation condition. Individuals in the cessation attempt condition attended their first lab session (T1) on the day immediately before quitting, individuals in the anticipated cessation condition attended this session 8 days before their anticipated quit date. Participants completed the DASS and QSU-B, along with several other measures, during this first lab session.

Following this, participants were randomly assigned to one of the three experimental psychoeducation conditions. In the *metacognition* condition, this presentation focused on the nature of cravings and thoughts about smoking, with the goal of reducing maladaptive appraisals and responses to craving-related thoughts, images and impulses. In the *psychoeducation control* condition, discussion focused on smoking risk factors and common cessation methods, with the goal of matching the metacognitive discussion's level of information, relevance to smoking cessation, experimenter attention, and participant involvement. This condition was not expected to produce any observable changes in measures of metacognition. The *no psychoeducation control* condition was intended as a second comparison group that does not provide these non-specific treatment effects. In this condition, participants did not receive any supplementary psychoeducation and instead spent time completing a few additional questionnaires.

All participants attended the second lab session 96 hours later (T2), when they completed the DASS and QSU-B a second time, along with all of the other measures used in the present analyses.

7.1.4 Analytic Overview

Three sets of analyses were conducted to address the current research questions. First, factor analysis was used to examine relationships between metacognitive responses

to cravings. If thought suppression is a problematic strategy, one might expect it to share significant common variance with other theoretically detrimental strategies like punishment, worry and rumination. If suppression is a more normative or even potentially helpful coping strategy, it may instead affiliate with strategies like distraction, social coping and re-appraisal. Second, correlational analyses examined the relationship between use of particular types of metacognitive responses as identified by the factor analysis and specific cessation outcome variables (withdrawal, negative affect, smoking behaviour) in the interests of clarifying the meaning of the factors. Finally, multivariate analysis of variance was used to assess differences between experimental conditions on use of the various thought control strategies. Analyses were conducted both using the natural experimental manipulations (i.e., comparing people assigned to quit versus smoke regularly) as well as by cessation outcome (i.e., comparing regular smokers with successful and unsuccessful abstainers).

7.2 Results

7.2.1 Relationships Between Metacognitive Responses to Cravings

7.2.1.1 Correlations Between Strategies

Table 14 presents correlations between metacognitive response strategies used by participants across groups (all measured at T2).

Table 14

Correlations Between Thought Control Strategies at T2

	Social (TCQ)	Worry (TCQ)†	Punish. (TCQ)†	Re-app. (TCQ)	Suppress. (WBSI)	Reflect. (RRS)	Brood. (RRS)
Distraction (TCQ)	-.06	.26	.18	.50	.54	.10	.07
Social (TCQ)		-.19	-.16	-.06	-.11	-.05	-.17
Worry (TCQ)†			.55	.32	.25	.25	.44
Punishment (TCQ)†				.33	.22	.31	.45
Re-appraisal (TCQ)					.31	.35	.33
Suppression (WBSI)						.04	.16
Reflection (RRS)							.66

† log transformed for analyses. N = 170. $r_{95\%crit.}$ = .15

7.2.1.2 Factor Analysis. How do the Different Coping Strategies Interrelate?

An exploratory factor analysis was performed on thought suppression, rumination (brooding subscale), and the TCQ subscales of distraction, re-appraisal, worry and punishment to identify shared patterns of variance among the various strategies for coping with thoughts. The social subscale of the TCQ was omitted from analysis because it correlated less than 0.2 with all other subscales, indicating an absence of substantial common variance with the other strategies.

Analyses were conducted using SPSS 17.0 using Maximum Likelihood extraction[4]. Kaiser's Meyer Olkin measure of sampling adequacy was .70, suggesting that the analysis should yield reliable factors (Field, 2000). Bartlett's test of sphericity was also significant (χ^2 (15) = 257.18, $p < .001$), confirming the presence of a relationship between the variables. Two factors with eigenvalues greater than one were extracted, accounting for a cumulative 65.72% of the scale variance. Eigenvalues were 2.65 and 1.29, accounting for 44.21%, and 21.51% of the variance in the coping strategies, respectively. Investigation of the scree plot confirmed a clear break between the 2nd and 3rd factors. The ML Goodness-of-Fit test also indicated that a 2-factor model fit the data well (χ^2 (4) = 4.09, $p = .39$) while a 1-factor model did not (χ^2 (9) = 80.70, $p < .001$). Together, this information suggests the presence of two common factors underlying the various thought control strategies. Using Direct Oblimin (i.e., oblique) rotation, two moderately correlated factors emerged ($r = .38$). No scale loaded higher than .30 on more than one factor. Communalities and factor loadings are shown in Table 15.

[4] Although principal axis is more widely used extraction method, many statisticians prefer ML because it produces more reliable estimates and permits testing of hypotheses about number of factors (Bickel & Doksum, 1977; Lawley & Maxwell, 1971).

Table 15

Factor Analysis of Responses to Thoughts (N = 170)

Scale	*Factor 1*	*Factor 2*	h^2
TCQ Distraction	1.06		.44
WBSI-S Thought Suppression	.53		.31
TCQ Reappraisal	.45		.36
TCQ Punishment		.74	.38
RRS Rumination		.67	.31
TCQ Worry		.67	.38

Note: Factor pattern loadings <.30 are not shown.

To note, one factor loading is above 1.00, indicating that some caution should be used in interpreting this solution. Nevertheless, the results of this analysis are intriguing, in that thought suppression shares the most variance with Distraction and Reappraisal--arguably "adaptive" strategies for coping with thoughts. Rumination, on the other hand, is aligned with Punishment and Worry, which are theoretically "maladaptive" responses to thoughts, or potentially, responses associated with negative emotion. Alternative factor interpretations also exist. The first factor, for example, could reflect a common focus on thoughts as a strategy for coping with cravings (e.g., distract, push away and think differently about craving cognition), while second factor could reflect a negative focus on the self (e.g., self-blame and worry).

Is there any evidence available to clarify the conceptualization of these factors? Factor scores were calculated to permit further exploration of these ideas. Zero-order correlations between factor scores and craving severity, negative affect, withdrawal and smoking behaviour are provided in Table 16. Smoking variables were adjusted for T1 scores when available to reduce within-person error variance (i.e., are residualized gain scores).

Table 16
Correlations Between Metacognitive Responses and Smoking Variables

	Factor 1 Scores	Factor 2 Scores
Smoking†	-.30**	-.09
CO level	-.23*	-.01
Desire to smoke (QSU-B-desire)	-.15*	.12
Need to smoke for relief (QSU-B-relief)	-.08	.19*
Negative Affect (DASS)	.19*	.66**
Withdrawal (MNWS)	.23*	.57**

Note: All measures represent residualized gain scores (i.e., T2 scores adjusted for T1), with the exception of the MNWS. † log transformed for analyses. N = 169. $r_{95\%\text{crit.}}$ = .15

Given that attempting to quit smoking obviously influences these outcome variables, partial correlations controlling for cessation attempt are also provided in Table 17. Smoking variables were again adjusted for T1 scores when available to reduce within-person error variance (i.e., are residualized gain scores). Significant small to moderate partial correlations continued to be observed between Factor 2 (punishment, worry, rumination) and subjective distress (withdrawal, negative affect, urges to smoke) but not with smoking behavior. After accounting for cessation status, Factor 1 only correlated significantly with withdrawal (small effect size).

Table 17

Partial Correlations Between Metacognitive Responses and Smoking Variables

	Factor 1 Scores	Factor 2 Scores
Smoking†	-.11	-.005
CO level	-.08	-.07
Desire to smoke (QSU-B-desire)	-.11	.16*
Need to smoke for relief (QSU-B-relief)	-.03	.23**
Negative Affect (DASS)	.13	.45**
Withdrawal (MNWS)	.16*	.58**

Note: All measures represent residualized gain scores (i.e., T2 scores adjusted for T1), with the exception of the MNWS. Partial correlations control for cessation condition (assigned to quit or not). † log transformed for analyses. Pairwise N's = 109 - 162.

7.2.2 MANOVAs

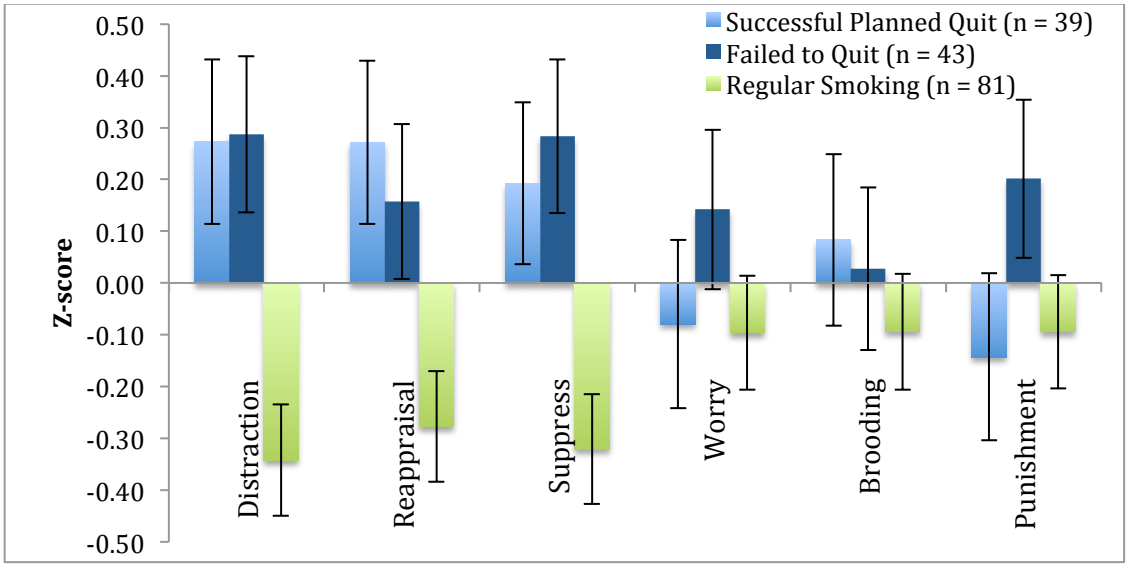
A 2 (cessation date) x 3 (psychoeducation condition) MANOVA examined experimental effects on metacognitive responses (TCQ subscales, RRS, WBSI-suppress). The omnibus MANOVA indicated a significant main effect of cessation condition, F (7, 156) = 3.09, p =.004, η^2 = .12. There were no differences between psychoeducation conditions, F (14, 314) = 0.90, p =.56, η^2 = .04, nor was there a significant interaction between experimental conditions, F (14, 314) = 0.85, p =.61, η^2 = .04. Follow-up t-tests indicated that individuals who quit smoking reported using significantly more distraction, t (162) = 3.81, p < .001, η^2 = .08, re-appraisal, t (162) = 2.84, p = .004, η^2 = .05, and suppression, t (162) = 3.51, p < .001, η^2 = .08, in response to smoking-related thoughts than individuals continuing to smoke regularly. Cessation groups did not differ on remaining thought control strategies, p's >.24, η^2's < .009.

To examine whether cessation outcome matters, analyses were repeated with cessation status broken down into "successful" and "unsuccessful" abstainers, thus creating a 3 (cessation status) x 3 (psychoeducation condition) MANOVA. The omnibus MANOVA again indicated a significant main effect of cessation condition, F (14, 298) = 1.99, p =.02, η^2 = .09. There were no differences between psychoeducation conditions, F (14, 298) = 1.02, p =.43, η^2 = .05, nor was there a significant interaction between experimental conditions, F (28, 604) = 0.75, p =.82, η^2 = .03. Follow-up ANOVAs indicated the presence of significant cessation outcome group differences on use of distraction, suppression and reappraisal, F's (2, 154) > 5.28, p's <.006, η^2's >.06. Fisher's LSD post-hocs indicated that regular smokers used significantly less of all three strategies, relative to both successful abstainers, p's < .007, and unsuccessful abstainers, p's <.014. There were no differences in use of strategies between successful and unsuccessful abstainers, p's >.76. Figure 10 illustrates.

Results were not moderated by gender, ethnicity, employment status, duration

smoking, use of nicotine replacement aides, nicotine dependence level, negative affect, withdrawal, craving severity or anxiety sensitivity. These potential moderators were tested by re-running analyses and including these variables as additional predictors in models. Nonsignificant interactions with key predictors (i.e., metacognitive beliefs or smoking-related variables) were taken to indicate lack of moderation, all *p*'s <.05.

Figure 10. Metacognitive Responses by Cessation Outcome Status



7.2.3 One-Month Follow-Up

Examination of correlational relationships between one-month outcomes and metacognitive beliefs and responses indicated that greater rumination was associated with smoking more at the follow-up (residualized gain scores, after covarying out T1 smoking), *r* = .16, *p* = .04, as well as a briefer duration of cessation, *r* = -.17, *p* = .03. Similarly, there was a trend for individuals who worried more to report smoking more cigarettes per day at the follow-up, *r* = .15, *p* = .07. Smoking outcomes were unrelated to all other metacognitive responses, |*r*'s| ≤ .09, *p's* ≥ .24. When rumination was entered into a regression analysis alongside other significant predictors of number of cigarettes per day at follow-up (QSU-B-

desire and MNWS), it did not contribute significant incremental variance to the prediction of either number of cigarettes smoked per day, β = .09, t = 0.90, p = .37 or duration of cessation, β < .001, t = 0.004, p = .99. This suggests the effects of rumination on one-month outcomes are fully explained by shared variance with craving and other nicotine withdrawal symptoms.

7.3 Summary

Suppression, rumination, punishment and worry are typically thought to belong to the same category of "maladaptive" thought control strategies. However, thought suppression correlated with the theoretically "adaptive" strategies of distraction (r = .54) and re-appraisal (r = .31) at least as strongly as with the "maladaptive" worry (r = .25), punishment (r = .22) and brooding (r = .16). Consistent with this, factor analysis revealed a 2-factor solution, with one factor comprised of suppression, reappraisal and distraction and the other comprised of punishment, worry and rumination. Interpretation of the shared variance underlying these factors is debatable. One possibility is that the first factor represents "thought-focused" strategies (i.e., ways of responding to thoughts—push them away, distract, think differently about them), while the other represents responses that focus negatively on the self (e.g., blaming, ruminating). There are several other plausible labels. The first factor could represent "adaptive" strategies while the second represents the "maladaptive". The first could be products of neutral or positive affect, while the second, corollaries of negative affect. The first could be "ways people respond to general cravings", the second "ways people specifically respond to cravings triggered by distress".

Greater use of the first factor was associated with smoking fewer cigarettes, lower CO levels and decreased desire to smoke. It was also weakly associated with greater negative affect and withdrawal symptoms. Together, this seems to suggest that use of the first set of strategies is associated with more favourable smoking outcomes, particularly if some degree of negative affect and withdrawal symptoms are regarded as a feature of

successful smoking reduction. However, when analyses partialled out variance explained by simply attempting to quit smoking (i.e., the experimental manipulation), these correlations all but disappeared. This implies that these are strategies commonly used by people attempting to reduce their smoking, but are not necessarily strategies that *help* people reduce their smoking. The second factor was not related to smoking behaviour or desire to smoke, but was strongly correlated with negative affect and withdrawal. It also correlated with need to smoke for relief. Interestingly, these correlations held up after accounting for whether people were trying to reduce their smoking or not. This suggests that the second set of strategies is strongly linked to subjective distress among both regular smokers and people attempting to quit.

These conclusions are further supported by the MANOVA results, which indicated that people attempting to quit smoking made more frequent use of distraction, suppression and reappraisal. There were no differences between successful and unsuccessful abstainers in the use of these strategies. Thus, while these appear to be strategies commonly used during cessation, they do not seem to confer any relative advantage (or disadvantage) individually. Interestingly, these results do not support the notion that thought suppression is universally a problematic *or* useful strategy.

While smoking behaviour at T2 was generally unrelated to both the "negative, self-focused" factor and individual use of punishment, worry and rumination, smokers using these strategies concurrently reported experiencing stronger urges to smoke and more subjective distress. Tendency to ruminate was also associated with smoking more at the one-month follow-up and a shorter duration of cessation attempt, an effect that appeared to be explained by shared variance with craving and nicotine withdrawal symptoms. Together, this suggests that punishment, worry and rumination strategies may be best considered a function (or precipitant) of distress. This is intriguing, regardless of the causal direction. That is, if people use these techniques because they are having a subjectively difficult time (i.e.,

distress is causing negative, self-focused coping), this style of coping is not actually helping them smoke any less and therefore, is not useful. Thinking about the other causal direction, these techniques may even exacerbate negative affect (i.e., self blame and worry cause a person to feel worse) and again, not assist with cessation success. Either way then, use of these strategies is unlikely to be a productive enterprise.

It is also worth noting the absence of an effect of metacognitive psychoeducation on responses to cravings. Metacognitive models suggest that overly significant appraisals of cravings prompt use of avoidant and otherwise problematic control strategies (which in turn escalate cravings). If this is true, than one would expect that reducing appraisals would decrease use of suppression, punishment, worry and rumination—in other words, there should be a main effect of psychoeducation condition such that the MC group produces lower "maladaptive" T2 responses. However, while the metacognition condition reduced maladaptive appraisals, it did not have an impact on use of specific thought control strategies like punishment, rumination, worry and thought suppression. This suggests a couple of possibilities. For one, the metacognitive psychoeducation may not have produced a strong enough effect on appraisals to change the ways people actually respond to cravings. To the extent that these metacognitive responses are an essential part of the model, this could be part of the reason that an effect of psychoeducation on T2 QSU-B cravings was not observed. Another explanation could be that appraisals are not the only reason people employ punishment, worry and suppression strategies. For example, people may denigrate themselves for thinking so much about cravings because they actually think it will help them refrain from smoking, rather than because they think cravings mean anything negative about themselves or their quit attempt. In other words, for some people punishment responses could be a mental analogy to snapping a rubber band on one's wrist in order to stop nail-biting. Either way, future research into the correlates and causal effects of metacognitive responses is warranted.

Chapter 8: Conclusions

8.1 Recap of Study Aims and Hypotheses

The present study represents an investigation of metacognitive models of cravings among smokers. Metacognitive models suggest that the ways people think about and respond to thoughts, urges and impulses affect how distressing and recurrent the unwanted cognition becomes. Specifically, individuals who appraise craving-related thoughts to mean something awful about themselves or their quit attempt (i.e., as meaning that they are weak-willed, destined to fail, or out of control) are predicted to be more distressed by cravings. In turn, negative affect is theorized to trigger urges to smoke and motivate unhelpful coping responses like suppression and rumination, which are hypothesized to further exacerbate unwanted thoughts about smoking. Investigation of this model is important because metacognitive theories are theorized to hold true without regard to the content of the unwanted thought. In addition, this model provides a novel way to conceptualize substance use urges and implies that modification of specific maladaptive beliefs and responses may be valuable clinical tools.

The current study addresses several key gaps in the existing literature. For one, previous research has found correlations between metacognitive beliefs, cravings and negative affect (e.g. Nosen & Woody, 2009). However, only one study has used a measure designed to assess metacognitive beliefs specific to smoking and no studies have examined these relationships among smokers in the early days of a cessation attempt, which is a period of central relevance to relapse processes. As such, the first aim of the current study was to continue development of a metacognitive belief measure and to replicate previously observed cross-sectional correlations among both regular smokers and active quitters.

Second, few prospective and no experimental tests of the beliefs component of the metacognitive model are available, despite clear directional propositions underlying the model. The current study manipulated both metacognitive beliefs and smoking cessation in

effort to tease apart these relationships. Based on metacognitive models, I hypothesized that decreasing theoretically maladaptive metacognitive appraisals via psychoeducation would decrease cravings and distress during smoking cessation. However, it is also plausible that correlations between cravings and metacognitive beliefs exist because distress, withdrawal and craving associated with cessation increases maladaptive beliefs (e.g., in line with mood-congruent information processing). As a test of this alternative directional pathway, smoking cessation was manipulated in order to observe the effects of increased cessation-related withdrawal symptoms on metacognitive beliefs and responses.

Finally, the third aim was to examine the veracity of claims thought suppression, punishment and rumination are problematic response styles that increase the persistence of unwanted thoughts. To the extent that this is true, maladaptive response styles were expected to share significant common variance, to correlate with indices of cessation difficulty (e.g., distress, withdrawal, craving) and to be used more frequently by unsuccessful quitters. These aims will be discussed in turn.

8.2 Measure Development and Cross-Sectional Correlations

Aim 1: Continue development of a metacognitive belief measures and replicate previously observed cross-sectional correlations among regular smokers and active quitters

One goal of the study was to continue development of the Appraisals of Craving Questionnaire (ACQ) and Catastrophic Appraisals Index (CAI), which were designed by Nosen and Woody (2009) to assess problematic metacognitive beliefs specific to smoking-related thoughts. Analyses supported refinement of the ACQ and CAI to 13 and 10 items, respectively. These scales demonstrated strong internal consistency. Four-day test-retest reliability was adequate for the CAI (r = .73), but slightly lower for the ACQ (r = .59). Convergent and discriminant validity were also sufficient. Specifically, while both scales correlated strongly with other measures of overly negative interpretations of thoughts and discomfort with emotions and other internal sensations, correlations with more general

aspects of metacognition (e.g., beliefs about memory) were relatively lower. Together, this evidence suggests that the ACQ and CAI are satisfactory measures of metacognitive beliefs among smokers. Given the dearth of validated substance-specific measures of metacognitive beliefs, this is an important step towards facilitating further research in this area.

Previous work has demonstrated moderate positive correlations between metacognitive beliefs and negative affect in both regular smokers and smokers who began a quit attempt within the past 6 months (Nosen & Woody, 2009; Spada, Nikčević et al., 2007). Cross-sectional correlations replicated this result. Specifically, people experiencing greater negative affect and nicotine withdrawal symptoms tend to believe that cravings and worry-related thoughts are a negative reflection on oneself (e.g., "I'm weak") or one's quit attempt (e.g., "I'm destined to fail"), and are important to control. This pattern was consistent across those actively smoking and withdrawing from nicotine, suggestive of a robust relationship. This is also the first study to demonstrate these correlations among smokers within the first several days of a quit attempt, a temporal period of central relevance to understanding relapse processes.

Congruent with metacognitive models, Nosen and Woody (2009) also found small to moderate correlations between metacognitive beliefs and urges to smoke in relatively recent quitters. The present study demonstrates that beliefs and urges are also related among active smokers. Specifically, smokers who tend to make a big deal out of craving- and worry-related thoughts (e.g., who think these thoughts can drive a person crazy and are important to control) tend to experience stronger desires to smoke, particularly to provide relief from negative affect. The beliefs tapped by the CAI (e.g., beliefs that smoking-related thoughts are dangerous) appear particularly relevant, as they correlated with urges to smoke for relief among all active smokers (i.e., both continuing smokers and unsuccessful quitters), even after accounting for shared variance with negative affect.

Interestingly, the same relationship between urges and beliefs was not observed among individuals who successfully abstained from smoking for three days. While desire to control thoughts correlated positively with urges to smoke, other types of metacognitive beliefs were generally unrelated to craving intensity at T2. One possible explanation for this is that assessment of cravings at one single time point (i.e., at T2) may not adequately capture the dynamics of this relationship among abstaining smokers. Indeed, cravings have been shown to fluctuate over the course of the day and tend to decline over the quit period (Shiffman, Engberg, et al., 1997). Successful abstinence may thus introduce variance in cravings and/or beliefs that obscure this relationship at certain time points.

8.3 Longitudinal and Experimental Outcomes

Aim 2: prospective and experimental tests of the beliefs component of the metacognitive model

The current study manipulated both metacognitive beliefs and smoking cessation in an effort to examine the directionality of observed cross-sectional relationships. First, based on metacognitive models, I hypothesized that decreasing theoretically maladaptive metacognitive appraisals via psychoeducation would decrease distress and cravings during smoking cessation. This hypothesis was partially supported. While metacognitive psychoeducation produced a moderate sized decrease in beliefs (as assessed via the ACQ), it did not have a significant impact on craving, withdrawal or distress at T2. However, psychoeducation did affect cravings during the first 24 hours of abstinence from cigarettes. Specifically, both regular and metacognitive psychoeducation produced lower cravings earlier in the day than no psychoeducation. The metacognitive condition conferred a relative advantage later in day—while cravings continued to rise for abstaining individuals receiving regular or no psychoeducation, cravings plateaued and even began to drop later in the day for those receiving metacognitive psychoeducation. These effects are consistent with metacognitive models, which suggest that acceptance and tolerance-based approaches to

cravings may reduce unhelpful over-reactions to cravings and therefore prevent unnecessary exacerbations in cravings. This is also consistent with the idea that more temporally fine-grained analyses may be necessary to observe the effects of metacognitive beliefs on craving severity among smokers in the early days of a cessation attempt. Finally, this finding is notable because elevations in urge to smoke during the first 24 hours of a cessation attempt, particularly those occurring shortly after waking, have been shown to prospectively predict abstinence status among smokers attempting to quit (al'Absi et al., 2004; Shiffman, Engberg, et al., 1997).

To note, differences between psychoeducation groups were only apparent among the small subsample of individuals successfully abstaining from cigarettes, not among all quitters. While this is understandable from the perspective that including continuing smokers might occlude group differences in craving, replication with a larger sample of abstainers would increase confidence in results. In addition, effects of metacognitive psychoeducation at T2 may not have been observed due to the power of the manipulation. As cognitive therapies typically aim to reduce maladaptive beliefs over the course of 1-12 one-hour sessions, this is likely in part due to the brevity of the intervention. That said, current smoking cessation interventions tend to be very time limited and studies have demonstrated that even 10 to 60 minutes of counseling can improve abstinence rates (Fiore et al., 2008). Psychoeducation was accordingly kept brief to maximize the ease and likelihood of it being adopted as an addendum to current cessation counseling practices. Nevertheless, a longer or more intensive intervention may have produced larger effect sizes and provided a stronger test of the metacognitive model. Similarly, while moderate decreases in ACQ scores were observed, the psychoeducation effect size was small and not maintained over time for the CAI. To the extent that the types of extreme appraisals measured by the CAI are critical to the metacognitive cycle, the experimental analyses may not have been adequately sensitive to this effect. Non-experimental analyses support this possibility, as change in the

more extreme metacognitive beliefs assessed by the CAI was a stronger predictor of change in negative affect, symptoms of withdrawal and urge to smoke than the ACQ. Identifying effective strategies for reducing CAI types of appraisals may accordingly be a fruitful area for future research.

Thus, analyses show some evidence to support the idea that metacognitive beliefs affect cravings. By manipulating smoking cessation, I also aimed to examine the reverse directional hypothesis, which is that increases in craving and withdrawal (i.e., as evoked by initiating a quit attempt) affect metacognitive beliefs. This hypothesis was also partially supported. Contrary to expectations, beginning a cessation attempt did not increase metacognitive beliefs at T2. However, several factors suggest that the non-experimental results may be more informative in this regard. In particular, a high percentage of quitters had already relapsed before three days, which could arguably mask group differences. Additionally, urges to smoke actually *decreased* over time among many individuals who continued to abstain from smoking.

Non-experimental analyses indicated that individuals successful in abstaining from smoking experienced a significantly greater decline in ACQ scores than either regular smokers or unsuccessful quitters. Change in metacognitive beliefs was predicted by change in negative affect and to a marginal extent, urges to smoke to relieve negative affect. This suggests that mood-congruent information processing effects may be operating, such that feeling more depressed, anxious and stressed increases self-focus, attention towards negative stimuli and personally-relevant attributions for failure (Forgas & Locke, 2005; Koster et al., 2005; Krohne et al., 2002). In this respect, being in a negative mood could predispose smokers to view their cravings as more deleterious, personally reflective and important to control. To the extent that “successful” quitters experienced less negative affect and lower urges to smoke to relieve this distress, this could also explain why this group demonstrated relatively lower appraisals at T2. These interpretations are congruent with

models positing a central role for negative affect in the nicotine withdrawal process (Baker et al., 2004). A valuable next step in this line of research would be to examine these hypotheses by directly manipulating negative affect or urge to smoke (e.g., using a mood induction or cue-reactivity paradigm) and observing effects on appraisals of smoking-related thoughts.

8.4 Metacognitive Responses

Aim 3: examine evidence for theories that thought suppression, punishment and rumination are generally maladaptive

Overly meaningful appraisals are thought to elicit distress and maladaptive coping responses (e.g., suppression, rumination, punishment), which in turn exacerbate intrusion frequency, increase the accessibility of negative self-referent information and prevent corrective learning (Rachman, 1997, 1998; Salkovskis, 1985; Wells, 2000). Limited research has examined the role of metacognitive responses in smoking cessation, however. The majority of attention has been paid to thought suppression, but evidence has been decidedly mixed. Accordingly, the current study sought to examine evidence for theories that suppression, rumination, worry and punishment are problematic response styles among smokers.

Overall, results provide some support for metacognitive conceptualizations of rumination, punishment and worry, such that they frequently co-occur and correlate with both beliefs about cravings and subjective distress. Factor analysis indicated that punishment, worry and rumination share substantial common variance, consistent with conceptualization of these strategies as a collective of responses that reflect a shared ("maladaptive" or "distressed") latent construct. Smokers using these strategies tended to believe cravings are a negative reflection on themselves (e.g., "I'm weak") or their quit attempt (e.g., "I'm destined to fail") and tended to think worrying is helpful, although potentially dangerous and important to control. Smokers using punishment, worry and

rumination also tended to be more distressed and experienced greater symptoms of nicotine withdrawal (e.g., irritability, sleeplessness, hunger) and urges to smoke to relieve negative affect. Rumination was a significant predictor of self-reported smoking at the one-month follow-up, which suggests that this response style may be particularly relevant to smoking behaviour. These patterns were consistent across regular smokers and active quitters (successful or not).

Together, these results are consistent with metacognitive models, which suggest that smokers use punishment and rumination because they believe cravings mean something important and bad and that using these strategies exacerbates distress and cessation difficulty. Further study is required to examine the veracity of these interpretations. For example, researchers have shown that experimentally induced rumination increases negative affect (Nolen-Hoeksema & Morrow, 1993), it would be informative to observe the impact of a similar manipulation on distress and smoking behaviour.

A different pattern of results was observed for thought suppression. First, suppression was largely uncorrelated with metacognitive beliefs, which is inconsistent with metacognitive models. Second, factor analysis indicated that suppression actually has more in common with theoretically "adaptive" strategies like re-appraisal and distraction than with rumination, worry and punishment. Suppression was commonly used by people attempting to quit smoking, which is consistent with research indicating that almost *all* smokers report suppressing cravings during cessation (Salkovskis & Reynolds, 1994) and that focusing thoughts away from smoking is a common and efficacious coping technique (O'Connell et al., 2007). Interestingly, however, use of suppression was equally common among successful and unsuccessful abstainers, which suggests that it is not necessarily helping (or hindering) people's quit attempts. Thus, results indicate that suppression is commonly used during cessation but is not definitively good or bad.

One possible explanation is that there may be moderators that influence whether

suppression is useful or harmful. Antony and colleagues, for example, found that suppression appeared to be more helpful among individuals high in anxiety sensitivity (Rogojanski, Vettese, & Antony, 2011b), which suggests that individual difference factors may play a role. Similarly, some researchers posit that thought suppression may only be problematic to the extent that it is accompanied by overly meaningful interpretations of failure to control unwanted thoughts and impulses (Purdon, Rowa, & Antony, 2005). Context may also matter. Because suppressing more intense and frequent thoughts is presumably more difficult than is suppressing an occasional intrusion, suppression may be more or less effective at different levels of cigarette craving and in different situations. For example, suppressing thoughts about smoking when sitting at the computer may be a more effective response than trying not to think about cigarettes in a crowded smoky bar. Suppression applied flexibly based on context may therefore be useful, whereas overreliance on the strategy may create problems. This is consistent with suggestions that across forms of psychopathology, inflexible overreliance on suppression may be more problematic than simple use alone (Salters-Pedneault, Steenkamp, Litz, Kring, & Sloan, 2010).

There is also evidence from the social psychology literature that suggests that self-control is a limited resource, such that efforts to resist alcohol, chocolate consumption, or suppress thoughts and emotion consistently elicit decrements in ability to perform subsequent self-control tasks (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Hagger, Wood, Stiff, & Chatzisarantis, 2010; Muraven & Baumeister, 2000; Muraven, Tice, & Baumeister, 1998). This effect has been termed “ego depletion”. Thus, although metacognitive models have focused on the ironic effects of suppression as the mechanism underlying it’s problematic effects, it may be that suppression is actually acting as a form of ego-depletion. This possibility may help explain some inconsistencies in previous work as it implies that the extent to which suppression produces rebound in subsequent thoughts, emotions, cravings or behaviour may depend on variables like previous practice effects,

concurrent self-control demands, and the presence of rewards (Muraven, 2010a, 2010b; Tice, Baumeister, Shmueli, & Muraven, 2007). It would be valuable for future work to begin exploring evidence to support this conceptualization of suppression in substance use.

8.5 Areas for Future Research

Continued understanding of metacognitive models of cravings may be advanced in several ways. First, the beliefs tapped by the CAI (e.g., beliefs that smoking-related thoughts can drive you crazy) appear particularly relevant, as they correlated with urges to smoke among all active smokers (i.e., both continuing smokers and unsuccessful quitters) and predicted change in negative affect, withdrawal and cravings over and above the ACQ. However, the metacognitive psychoeducation did not produce enduring change in this measure. This is not particularly surprising, given the way the CAI is constructed—as items are dichotomized to reflect "no endorsement of belief" or "any degree of belief", change in appraisals would need to be absolute for an effect to be observed. Changing the response format of the CAI (e.g., switch from assessing degree of belief to a Likert-type agreement scale) may improve sensitivity to change. Ultimately, identifying effective strategies for reducing CAI types of appraisals would be a valuable next step towards clarifying the role of these metacognitive beliefs in cessation difficulty.

Further examination of the effects of successful abstinence on beliefs may be useful in this regard. Specifically, several aspects of the current study suggest that the cessation process may affect the relationship between beliefs and cravings. Successful abstainers, for example, showed decreases in metacognitive appraisals; effects of metacognitive psychoeducation on the diurnal course of cravings were also only apparent in this group. One possible explanation for this is that successful abstinence may provide an experiential learning opportunity. For example, by persisting through cravings without smoking, these individuals may come to understand that cravings are tolerable and that they do not mean anything negative about oneself or one's quit attempt. This process could be considered

congruent with the behavioural experiments commonly used in cognitive behavioural therapy to challenge maladaptive thinking patterns (Bennett-Levy, 2005).

Conceptually then, successfully abstaining from cigarettes may produce reductions in maladaptive appraisals of cravings; metacognitive psychoeducation may facilitate this process by reducing cravings both earlier and later in the day. From a treatment development perspective, this raises an intriguing possibility of combining cognitive and behavioural approaches to facilitate long-term cessation success. Behavioural contingency management (CM) approaches (i.e., paying people to quit smoking), for example, have been demonstrated to be very effective for inducing short periods of abstinence (Heil, Tidey, Holmes, Badger, & Higgins, 2003). These approaches increase both abstinence self-efficacy and future cessation success (Alessi, Badger, & Higgins, 2004; Heil, Alessi, Lussier, Badger, & Higgins, 2004). If brief periods of abstinence serve as a form of behavioural experiment that "teaches" smokers more adaptive, less negative ways of thinking about cravings short-term abstinence, this may be one mechanism underlying the efficacy of these approaches. Indeed, combining contingency management approaches with metacognitive psychoeducation could be an effective clinical approach that ensures both a high rate of abstinence (via the CM) and also makes cravings a little easier to tolerate (via the psychoeducation).

Further investigation of metacognitive processes among depressed populations may also be warranted. Individuals with histories of depression have been shown to engage in greater rumination and are prone to negative information processing biases (Raes, Hermans, & Williams, 2006; Robinson & Alloy, 2003; Spasojevic & Alloy, 2001). They also report greater subjective distress during cessation and are less likely to succeed in their attempt to quit smoking (Covey, Glassman, & Stetner; Glassman et al., 1990). Thus, depressed individuals may be more vulnerable to overly negative interpretations of cravings and use of punishment, worry and rumination, as well as exacerbations in negative affect

during cessation. Accordingly, reducing metacognitive beliefs (particularly those tapped by the CAI) and responses (especially rumination) may be particularly helpful for smokers with histories of depression.

In fact, it may be important for future research to assess the possibility that depression is serving as a third variable that helps explain observed relationships between metacognitive beliefs, responses and subjective distress. In the present study, controlling for negative affect (with a measure that includes depressive symptoms) did not eliminate observed relationships between beliefs and withdrawal symptoms. However, the possibility remains that there are omitted variables that drive both sides of the metacognitive model (i.e., endogeneity may be present). More comprehensive assessment of depression (and related variables) could help rule out this prospect.

The generalizability of results to other samples of smokers also remains to be demonstrated. For example, smokers who volunteer for intensive cessation interventions tend to be among the most (not least) motivated to quit (Hughes, Giovino, Kuevens, & Fiore, 1997). For the purposes of the current study, highly motivated individuals may actually be most relevant because of their potential interest in controlling craving-related thoughts. Nevertheless, results may differ among smokers who are not highly motivated to quit or who are unwilling to take time out of their busy schedule to participate in research. In a similar vein, future work may wish to examine whether metacognitive models are particularly relevant to a certain at risk group (e.g., women with histories of depression).

Finally, as the majority of measures were self-report, the extent to which demand characteristics are influencing results of manipulation checks are uncertain. For example, participants may have been more likely to report that metacognitive beliefs decreased following psychoeducation because they were trying to be compliant, rather than because of true change in beliefs. Inclusion of alternative measures of appraisals that are less sensitive to demand characteristics (e.g., implicit association tasks, see Teachman & Woody, 2006)

would increase confidence in results. Future work would also benefit from inclusion of additional behavioural or physiological measures of craving or distress. Examination of cortisol levels during the day, for example, may complement findings from self-report craving EMA data, as lower levels of cortisol in the first day of abstinence has been associated with increased stress, withdrawal symptoms, urges to smoke and likelihood of relapse (Ussher et al., 2011). Inclusion of additional biochemical measures of smoking may also be useful. While smoking was confirmed with a CO monitor, results are only sensitive to smoking within approximately the past 8-24 hours (Benowitz et al., 2002). Thus, it is possible that some individuals who smoked during the monitoring period were incorrectly classified as abstinent if they had not smoked on the day of the second lab session. Similarly, individuals smoking marijuana may register as "smokers" based on CO data, but may actually be abstinent from nicotine. While these errors are not expected to affect a large proportion of the sample, cotinine testing may increase confidence in classification and reduce associated error variance (Benowitz et al., 2002; Mabry et al., 2007).

8.6 Summary

The purpose of the present study was to examine metacognitive processes in smoking cessation. The first aim was to continue development of a metacognitive belief measure and to replicate previously observed cross-sectional correlations between beliefs and distress, cravings and withdrawal among both regular smokers and active quitters. The second aim was to examine potential directional relationships underlying these correlations via prospective and experimental tests of the beliefs component of the metacognitive model. Finally, the third aim was to examine evidence for theories that thought suppression, punishment, worry and rumination are generally maladaptive.

Results indicate that metacognitive models of cravings are relevant to the early days of cessation, a period of central importance in understanding relapse processes. Consistent with previous work, several types of metacognitive beliefs correlated with distress and

withdrawal symptoms among both continuing smokers and active quitters. The beliefs tapped by the CAI (e.g., beliefs that smoking-related thoughts are dangerous) appear particularly germane, as they correlated with urges to smoke among both continuing smokers and unsuccessful quitters, even after accounting for shared variance with negative affect.

The hypothesis that decreasing theoretically maladaptive metacognitive appraisals via psychoeducation would decrease distress and cravings during smoking cessation was partially supported. While metacognitive psychoeducation did not have a significant impact on craving, withdrawal or distress at T2, it did affect cravings during the first 24 hours of abstinence from cigarettes, such that cravings were relatively lower both early and later in the day. The more extreme metacognitive beliefs assessed by the CAI were also predictive of change in negative affect, symptoms of withdrawal and urge to smoke for relief.

Investigating an alternative directional pathway, the hypothesis that initiating a cessation attempt would increase maladaptive beliefs via an exacerbation in cravings, distress and withdrawal was not supported. However, nonexperimental findings indicated that successful abstainers showed a significantly greater decline in negative, overly meaningful appraisals of cravings than either regular smokers or unsuccessful quitters. Change in metacognitive beliefs was also predicted by change in negative affect and to a marginal extent, urges to smoke to relieve negative affect. Overall, these results are suggestive of a bidirectional relationship between metacognitive beliefs and negative affect, withdrawal and cravings.

Results also imply that certain metacognitive responses may play a role in cessation difficulty. Specifically, punishment, worry and rumination correlated with negative affect, nicotine withdrawal and urges to smoke to relieve negative affect; rumination was also a significant predictor of self-reported smoking at the one-month follow-up. Thought suppression, the response style most frequently regarded as detrimental, appeared to be a

commonly used strategy among all individuals attempting to quit smoking and was not demonstrably either harmful or helpful.

In sum, results provide insight into a novel way to conceptualize substance use urges and imply that modification of maladaptive beliefs and responses about cravings may be a valuable supplement to behavioural approaches to cessation interventions. Future research into clinical applications of metacognitive models among smokers abstaining from cigarettes, particularly with a focus on rumination and the types of appraisals tapped by the CAI, would be valuable.

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