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Responding to Tobacco Craving: Acceptance Versus Suppression

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by

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Abstract

Most treatments for substance use disorders (SUDs) are based on a model that craving is a primary cause of relapse, and therefore they emphasize skills for preventing and reducing craving. Acceptance and Commitment Therapy (ACT) provides a theoretical rationale for "acceptance" of drug-related thoughts and cravings, and proscribes suppression, a more intuitive and commonly used coping strategy. However, it remains largely unknown whether various coping strategies differentially affect craving intensity, drug use behavior, or other relevant outcomes during a craving episode. Using a randomized, between-subjects design (acceptance-based coping, suppression-based coping, or no coping instructions/control), the current study compared the effect of acceptance versus suppression of cigarette craving on outcomes including craving intensity, affect, self-control (i.e., stamina on a physically challenging task), and number of thoughts about smoking in the laboratory, and smoking behavior and self-efficacy for cessation during a 3-day follow-up period. Contrary to the hypothesis that acceptance would be superior to suppression, results indicated that both strategies were associated with reduced craving intensity, decreased negative affect, and increased positive affect in the laboratory, and greater self-efficacy for cessation at 3-day follow-up, compared to the control group. There were no significant differences across groups in smoking behavior during the 3-day follow-up. Exploratory moderation analyses that must be interpreted

cautiously suggested that the effects of acceptance and suppression on craving and affect may vary according to smoking rate and level of nicotine dependence. Overall, this study provides support for the value of acceptance-based coping strategies, but also suggests that more research is needed to differentiate their benefits compared to suppression-based coping.

Introduction

Various techniques for coping with drug craving are key elements of most empirically-supported treatments (Task Force on Promotion and Dissemination of Psychological Procedures, 1995) for substance use disorders (SUDs). One approach, Acceptance and Commitment Therapy (ACT) (Hayes, Strosahl, & Wilson, 2003), provides a theoretical rationale for "acceptance" of drug-related thoughts and cravings, and proscribes suppression, a more intuitive and commonly used coping strategy (Salkovskis & Reynolds, 1994). The current study compared acceptance versus suppression of cigarette craving on outcomes including craving intensity, affect, self-control performance (stamina on a physically challenging task), smoking behavior, and self-efficacy for cessation in laboratory and naturalistic settings.

The Elaborated Intrusion (EI) Theory of Desire

Craving, broadly defined as "the conscious experience of a desire to take a drug," (p. 33) has long been assumed to play a key role in the maintenance of SUDs (Drummond, 2001). However, it appears that craving is neither necessary nor sufficient for relapse (i.e., return to drug use following a period of abstinence) to occur (Drummond, 2001). Responding to the need for a more complete phenomenology of craving, Kavanagh and colleagues (Kavanagh, Andrade, & May, 2004, 2005) have recently proposed the Elaborated Intrusion (EI) Theory of Desire. According to EI theory, desire is a conscious, "affectively charged cognitive event in which an object or

activity that is associated with pleasure or relief of discomfort is in focal attention" (Kavanagh et al., 2005, p. 447). The experience of desire begins with seemingly spontaneous, automatic intrusive thoughts that are triggered by physiological deficit states (e.g., nicotine withdrawal) and learned associations (e.g., negative affect and external cues such as seeing someone smoke). These initially pleasurable and rewarding thoughts then prompt elaboration, a controlled and effortful process in which the thoughts are attended to and manipulated in working memory. Elaboration provokes additional intrusive thoughts and vivid imagery in a positive feedback loop (for evidence that craving, including tobacco craving, is indeed characterized by intrusive thoughts and vivid imagery, see Kavanagh et al., 2004; May, Andrade, Panabokke, & Kavanagh, 2004; Salkovskis & Reynolds, 1994). When the desired object (e.g., a cigarette) is not freely available, either voluntarily (e.g., during a cessation attempt) or involuntarily (e.g., when a smoker has run out of cigarettes), continued elaboration ultimately shifts the individual's affective state from primarily positive to negative as awareness of a sense of deficit and deprivation increases. During a cessation attempt, elaboration should also induce feelings of guilt and anxiety, because of the conflict between the initially rewarding thoughts and the goal of abstinence. EI theory predicts that interrupting elaboration should decrease the probability that craving will lead to relapse.

Thought Suppression and Ironic Process Theory

An intuitive, commonly employed strategy to interrupt elaboration is *thought suppression*; that is, deliberate, willful removal of unwanted thoughts from consciousness (Salkovskis & Reynolds, 1994). However, EI theory predicts, and empirical research suggests, that suppression may be counterproductive (Abramowitz, Tolin, & Street, 2001;

Wenzlaff & Wegner, 2000), resulting in an ironic "rebound effect" (i.e., increase in frequency of the unwanted thoughts) following a period of suppression (Abramowitz et al., 2001). Wegner (1994) proposed Ironic Process Theory (IPT) to explain this paradoxical effect. IPT posits that suppression involves two processes: an ironic, automatic monitoring process and a controlled, effortful operating process. The monitoring process searches for instances of the unwanted thought, which ironically heightens vigilance and sensitivity to the thought. Detection of the thought triggers the operating process, a conscious and effortful search for alternative distracter thoughts. Paradoxical "rebound" effects occur when the effortful operating process is interrupted or terminated but the automatic monitoring process continues.

Surprisingly, only one experimental study has investigated the effect of suppression of smoking-related thoughts, and found that individuals who suppressed their thoughts about smoking for five minutes reported a greater frequency of smoking-related thoughts both during the suppression period (called an immediate enhancement effect, or IEE) and during a five-minute period following suppression (rebound effect), compared to a group not instructed to suppress (Salkovskis & Reynolds, 1994). Other relevant experimental research has demonstrated that suppressing craving for alcohol increases the accessibility of alcohol-related concepts in memory, as evidenced by faster reaction time on an alcohol expectancy accessibility task (Palfai, Monti, Colby, & Rohsenow, 1997) and slower reaction time to name the ink color for "alcohol" compared to non-alcohol words in a Stroop task (Klein, 2007). Given that expectancy accessibility is associated with drinking behavior (e.g., Roehrich & Goldman, 1995), this research suggests that craving suppression could ironically increase drug consumption. Finally, two non-

experimental studies have found that intention to use suppression as a coping strategy was unrelated to success at smoking cessation (Haaga & Allison, 1994) and that smokers with a history of unsuccessful quit attempts had a higher general tendency to suppress thoughts than ex-smokers (Toll, Sobell, Wagner, & Sobell, 2001).

Thought Suppression and the Ego Depletion Model of Self-Control

The Ego Depletion Model of Self-Control (Muraven & Baumeister, 2000) provides an alternative but complementary perspective regarding the ironic effects of thought suppression. According to this model, all acts of self-control, defined as attempts to change, override, or suppress urges, thoughts, or behaviors that conflict with long-term goals, consume a common resource, or "energy," analogous to a muscle, such that a single act of self-control temporarily "depletes" this resource and impairs subsequent self-control efforts. For example, suppression of neutral thoughts (i.e., white bears) was associated with increased beer consumption when there was an incentive to limit consumption (Muraven, Collins, & Nienhaus, 2002), and suppression of alcohol craving during a cue exposure task undermined performance on two subsequent tasks requiring self-control (Muraven & Shmueli, 2006).

Acceptance as an Alternative to Suppression

The studies just reviewed were rooted in two different frameworks (Ironic Process Theory and Ego Depletion Model of Self-Control) but provide converging evidence to support the prediction of the EI Theory of Desire that coping with unwanted thoughts and urges by trying to suppress them ironically may increase their accessibility and impact on behavior. EI theory suggests that minimizing the potential for craving to lead to relapse requires avoiding *both* elaboration and suppression. Mindfulness-based coping (Kabat-

Zinn, 1990), which encourages observing and accepting one's thoughts while maintaining a "calm detachment" towards them (Kavanagh et al., 2004, p. 1364), is the recommended alternative.

Acceptance and Commitment Therapy (ACT) (Hayes, 2004; Hayes, Luoma, Bond, Masuda, & Lillis, 2006) promotes similar strategies and specifically proscribes suppression. The goal of ACT is to increase psychological flexibility by changing the function rather than the content of cognition via six core processes. One core process is acceptance, "the active and aware embrace of those private events occasioned by one's history without unnecessary attempts to change their frequency or form" (Hayes et al., 2006, p. 7). Another is cognitive defusion, used "to alter the undesirable functions of thoughts and other private events, rather than trying to alter their form, frequency, or situational sensitivity" (p. 8). Therefore, ACT may not reduce craving *per se*, but may shorten the duration and intensity of cravings by discouraging elaboration, and decrease the likelihood of *acting* on cravings by emphasizing control over behavior rather than thoughts and feelings.

ACT is often contrasted with cognitive-behavioral therapy (CBT), in which changing maladaptive cognitions is a primary goal and is theorized to mediate outcomes. In fact, it has been argued that the "control-based" strategies within CBT are functionally similar to suppression, which may explain why individuals with problems involving cravings who are treated with CBT often are successful initially but later relapse (e.g., Forman et al., 2007). However, this argument remains controversial (Hofmann & Asmundson, 2008).

Research on acceptance- and mindfulness-based approaches continues to proliferate, and results suggest that these approaches may be at least as effective as CBT (Hayes et al., 2006), although the literature focused on smoking cessation (Gifford et al., 2004; Hernandez-Lopez, Luciano, Bricker, Roales-Nieto, & Montesinos, 2009) and other SUDs remains small. Additionally, two process-oriented studies have shown that brief mindfulness-based instructions did not affect craving intensity but did result in decreased smoking behavior in college students (Bowen & Marlatt, 2009), and that reduction in substance use among prison inmates who attended a meditation course that emphasized acceptance-based techniques was partially mediated by self-reported decreases in avoidance and suppression of unwanted thoughts (Bowen, Witkiewitz, Dillworth, & Marlatt, 2007).

Studies that demonstrate advantages of acceptance versus suppression for coping with other types of unwanted thoughts and feelings are beginning to accumulate (e.g., Levitt, Brown, Orsillo, & Barlow, 2004). In one notable experimental study, Forman et al. (2007) randomly assigned undergraduates to receive a brief ACT- or CBT-based intervention for coping with chocolate craving, and then gave them a box of chocolates to carry for 48 hours. Results indicated that the ACT intervention was most effective for those high in trait level of susceptibility to food cravings, whereas the CBT intervention was most effective for those low in craving susceptibility, suggesting that ACT-based strategies may be particularly effective for those who struggle with cravings, such as individuals with SUDs.

The Current Study

The primary purpose of the current study was to compare acceptance-based versus suppression-based coping for cigarette craving in adult smokers who desired to quit smoking. It was predicted that compared to a control group given no coping instructions, both acceptance and suppression would result in decreased craving intensity and negative affect in the laboratory, and fewer cigarettes smoked and increased self-efficacy for cessation during a three-day follow-up period, but that acceptance would be superior to suppression. Additionally, it was hypothesized that only suppression would be associated with self-control depletion and a rebound effect in the laboratory.

Specific Aim 1: To compare the effect of acceptance versus suppression of urge to smoke on self-reported urge intensity and affect.

Hypothesis 1a) The use of either acceptance or suppression would result in decreased urge intensity, increased positive affect, and decreased negative affect compared to no coping instructions (control group).

Hypothesis 1b) Acceptance would be superior to suppression.

Specific Aim 2: To compare the effect of acceptance versus suppression of urge to smoke on number of thoughts about smoking and self-control.

Hypothesis 2a) The suppression group would report fewer thoughts about smoking than the acceptance and control groups, who were not predicted to differ from each other.

Hypothesis 2b) The suppression group would demonstrate less stamina on a physical challenge task requiring self-control (handgrip squeeze) than

the acceptance and control groups, who were not predicted to differ from each other.

Specific Aim 3: To determine whether suppression of urge to smoke results in a rebound effect.

Hypothesis 3a) A rebound effect would occur in the suppression group such that after they stopped actively suppressing, they would report greater urge intensity and negative affect, less positive affect, more smoking-related thoughts, and stronger motivation to act on craving (would request a greater amount of money to delay smoking) compared to the acceptance and control groups.

Hypothesis 3b) After they stopped actively using acceptance, the acceptance group would not experience a rebound effect and therefore would report less urge intensity and negative affect, more positive affect, and less motivation to act on craving compared to the control group.

Secondary/Exploratory Aim: To compare the effect of acceptance versus suppression of urge to smoke on smoking behavior and self-efficacy for smoking cessation during a 3-day follow-up period.

Hypothesis 4a): The acceptance and suppression groups would have a longer latency to smoke and smoke fewer cigarettes than the control group, and **4b)** acceptance would be superior to suppression.

Hypothesis 4c): The acceptance and suppression groups would report greater self-efficacy for smoking cessation than the control group, and **4d)** acceptance would be superior to suppression.

Method

Experimental Design and Overview

The current study employed a randomized, between-subjects design. Smokers who intended to try to quit smoking within six months completed baseline (time 1) measures and then were randomly assigned to one of three groups during smoking cue exposure: 1) acceptance-based coping, 2) suppression-based coping, or 3) no coping instructions (control group). Coping instructions were delivered via brief slide presentations just prior to cue exposure (the control group presentation was based on a neutral magazine article). After cue exposure, participants recorded smoking-related thoughts for several minutes while continuing to use their assigned coping strategy, followed by measurement of urge to smoke, affect, and self-control performance (time 2). To assess for rebound effects, participants were next asked to record smoking-related thoughts for several more minutes but to disregard their assigned strategy, and then they completed another measurement of urge, affect, and motivation to smoke (preference for a cigarette versus money) (time 3). Finally, participants tracked their smoking at home for three days while they attempted to quit and completed a measure of self-efficacy for cessation (3-day follow-up). This study was approved by the Institutional Review Board of the University of South Florida.

Participants

Participants included 162 adult smokers (81 males, 81 females) recruited in Tampa, Florida via flyers, online advertisements, word of mouth, and an established database of individuals interested in participating in research. Inclusion criteria were: 1) age 18 to 65, 2) smoking rate of at least 10 cigarettes per day for at least one year, 3) desire and intention to quit within 6 months, assessed using the Contemplation Ladder (Biener & Abrams, 1991), and a Stages of Change algorithm (DiClemente et al., 1991), 4) history of at least one previous quit attempt, 5) no current participation in a formal smoking cessation program (i.e., counseling), and 6) no current use of pharmacotherapy for smoking cessation.

Demographic and Baseline Measures

Note: The study also included other baseline measures (impulsivity, experiential avoidance) not described in this manuscript that will be used for potential future secondary analyses and an attempt to replicate and extend the findings of Litvin and Brandon (2010).

Demographic Questionnaire (DQ). Single items assessed participants' age, gender, marital status, race, ethnicity, education level, and household income (see Appendix A).

Exhaled Carbon Monoxide (CO). Participants provided a breath sample and were excluded from the study if their exhaled CO level was below 8 parts per million (ppm).

Smoking Status Questionnaire (SSQ). The SSQ contained questions about participants' current smoking pattern and smoking history, and the Fagerstrom Test for

Nicotine Dependence (FTND) (Heatherton, Kozlowski, Frecker, & Fagerström, 1991) (see Appendix B).

Smoking-Related Cognitions (SRC) (Salkovskis & Reynolds, 1994). To gather descriptive data about participants' previous quit attempts, they were asked to recall their most recent attempt and rate the following cognitions on 100mm visual analogue scales: how pleasant was the idea of having a cigarette; how much did you try to suppress ideas about smoking; how strong was the urge to smoke; how able did you feel to resist the idea of smoking; how strong was the urge to distract yourself from the idea of smoking in some way; how in control of ideas about smoking did you feel; how acceptable did you find the idea of smoking; how uncomfortable did ideas about smoking make you; how much did you think you would become relaxed if you had a cigarette *right now* (see Appendix C).

Manipulation Checks

"Quizzes" (adapted from Forman et al., 2007; Levitt et al., 2004) containing multiple-choice questions (3 for acceptance and suppression groups, 4 for control) tested participants' understanding of the coping instructions (for the control group, the questions tested memory of the magazine article content). Additional quiz items asked participants to rate on 5-point scales their perceived understanding and how interesting the information was to them. The acceptance and suppression groups also rated how useful they expected their strategy to be (see Appendices D, E, and F). The second manipulation check, administered after cue exposure, contained 6 items (3 related to acceptance, 3 related to suppression) to assess the extent to which participants used each strategy, regardless of group assignment (adapted from Levitt et al., 2004). Each item

was rated on an 8-point scale. An additional item for the acceptance and suppression groups assessed their perception of how useful their assigned strategy was on a 5-point scale. An additional item for the control group asked them to describe in their own words how they responded to their craving (see Appendix G).

Outcome Measures - Urge

Questionnaire of Smoking Urges-4 (QSU-4). The QSU-4 contained 4 items taken from the original 32-item Questionnaire of Smoking Urges (Tiffany & Drobes, 1991), 2 items to assess desire to smoke and 2 items to assess intention to smoke. Cronbach's alpha in this study ranged from .82 to .94 (see Appendix H).

One-Item Urge (1-Urge) (Sayette, Martin, Wertz, Shiffman, & Perrott, 2001). As a global craving assessment, participants rated their overall urge from 0 ("no craving at all") to 100 ("the most craving you can imagine") (see Appendix H).

Magnitude Estimation of Urge (ME) (Sayette et al., 2001). Using a fixed urge scale with a defined maximum value can artificially depress variability in urge ratings and prevent detection of reactivity effects among individuals who have a high urge at baseline. The ME, which is not susceptible to ceiling effects, was used as a secondary measure of urge. Participants compared their current urge to their baseline urge, which was arbitrarily assigned a value of 10. For example, a value of 20 would indicate an urge that had doubled since baseline (see Appendix H).

Outcome Measures - Affect

Mood Form (MF) (Diener & Emmons, 1984). The Mood Form was used to assess state and trait (past 3 weeks) mood. It consists of 4 adjectives that represent positive affect (e.g. happy) and 5 for negative affect (e.g., frustrated) that are rated on 7-

point scales and summed to produce total Positive Affect (PA) and Negative Affect (NA) scores. Reliability was high in the current sample for both the trait (α = .89 for PA, α = .89 for NA) and state (α = .90-.93 for PA, α = .84-.86 for NA) versions (see Appendices I and J).

One-Item Discomfort (1-Discomfort). Previous thought suppression studies have identified discomfort as an important component of affect to assess (e.g., Marcks & Woods, 2005). Participants rated their discomfort with thoughts about smoking and craving on a scale from 0 "not uncomfortable at all" to 100 "extremely uncomfortable" (see Appendix J).

Other Outcome Measures

Self-Control: Handgrip. Handgrip squeeze duration has been used as a reliable measure of self-control performance in previous research (e.g., Muraven & Shmueli, 2006; Muraven, Tice, & Baumeister, 1998). The handgrip consists of two padded handles connected by a spring. Participants were instructed to squeeze the handgrip for as long as they could around a small pad of paper that was placed between the handles. A stopwatch was used to record the length of time until the paper fell, signaling that participants had relaxed their grip.

Number of Thoughts about Smoking (Salkovskis & Reynolds, 1994). Participants recorded their thoughts about smoking by pressing a button on a hand-held golf counter once for each thought. The numbers on the counter were covered to reduce participants' attention to how many thoughts they were having.

Behavioral Choice Task (BCT) (adapted from Sayette et al., 2001). To assess motivation to act on craving, participants chose between smoking a cigarette immediately

or delaying smoking until the study was over in exchange for monetary compensation. To begin this task, participants were asked if they would be willing to delay smoking in exchange for $50. The experimenter continued to suggest lower values until participants decided that they would prefer to smoke rather than accept the proposed amount. The minimum acceptable amount (to the nearest $0.25) was determined. Participants were then informed that the laboratory portion of the study was over (so there would be no smoke break), and they would receive an extra $5.

Cigarettes Smoked and Latency to Smoke. Participants were given tracking sheets designed to fit in their cigarette pack to record the exact time of the first cigarette they smoked after leaving the laboratory and to tally the rest of the cigarettes they smoked for the following three days, divided into 3-hour blocks. Participants were told to keep the tally sheets with them at all times and record their cigarettes as they smoked them. To obtain a measure of participants' latency to smoke their first cigarette after leaving the laboratory, the time they left was subtracted from the time they recorded for their first cigarette (see Appendix K).

One-Item Self-Efficacy (1-SE). As a global measure of self-efficacy for cessation, participants rated their confidence that they could achieve one year of abstinence on a scale from 0 "not confident at all" to 100 "extremely confident" (see Appendix L).

Smoking: Self-Efficacy/Temptation Long Form (SET) (Velicer, Diclemente, Rossi, & Prochaska, 1990). This measure contains 20 items rated on a 5-point scale and was used to assess participants' confidence in avoiding smoking in positive affect/social situations (PASS), negative affect situations (NAS), and habitual/craving situations (HCS). Alphas for the current sample were .90-.94 (see Appendix L).

Procedure

Recruitment. Interested individuals completed a screening survey by phone or online using http://www.surveymonkey.com. Those who qualified were scheduled for an individual appointment expected to last 1.5 hours. To create a standardized, moderate deprivation (i.e., craving) state, they were asked to abstain from smoking for 3 hours prior to the appointment and told they would be given a breath test that could detect recent smoking.

Consent and eligibility verification. After obtaining informed consent, the experimenter verified participants' eligibility, including that their exhaled CO level was at least 8 ppm, and asked the participant to state the time of their last cigarette to confirm that they had not smoked for 3 hours. The experimenter then collected their pack of cigarettes and lighter, which were returned at the end of the session.

Part I: Baseline (time 1) measures and randomization. First, participants squeezed the handgrip for as long as they could and second, completed the following baseline measures: demographic questionnaire, SSQ, SRC, 1-SE, SET, MF (trait), MF (state), 1-Discomfort, QSU-4, and 1-Urge. Next, the experimenter left the room while participants recorded their thoughts about smoking for 3 minutes. They were told that they could think about anything they wished, and if they happened to have a thought about smoking, they should press the button on the counter provided once per smoking thought. Participants were then randomly assigned to one of three groups for the coping manipulation: 1) acceptance, 2) suppression, or 3) no coping instructions/control group. Randomization was stratified by gender (however, no gender differences in primary

outcomes were found) using http://www.randomization.com, which employs the method of random permuted blocks.

Part II: Coping manipulation. Participants in the acceptance and suppression groups were engaged in a brief dialogue about their previous cessation experiences, informed that the main purpose of the study was to evaluate a strategy for responding to craving that might help people quit smoking, and given a description of the cue exposure task, which they were told would serve as an opportunity to practice the strategy. Participants in the control group were told that one purpose of the study was to evaluate the effect of nicotine on cognitive abilities such as attention and comprehension. They were also given a brief description of the cue exposure task but no information about craving or coping strategies. All participants were then seated in front of a computer monitor to view a 10-minute slide presentation that described how to use their assigned strategy to cope with cigarette craving (acceptance and suppression groups) or an expanded version of a *National Geographic Explorer* article with a neutral theme (control group) (see Appendices M, N, and O). The presentations for the acceptance and suppression groups were adapted from audio scripts used by Levitt et al. (2004) and Forman et al. (2007). All presentations included audio narration and colorful text and graphics. All participants were told before viewing their presentation that a memory quiz would be administered afterward. If a participant answered more than one item incorrectly, the experimenter reviewed the main ideas until she was confident that the participant understood.

Part III: Cue exposure task. After participants viewed their presentation and completed the quiz, the experimenter placed a covered tray in front of them and began the

cue exposure task. Previous research has demonstrated that craving during cue exposure is increased when participants have an expectation that they might smoke in the laboratory (Juliano & Brandon, 1998). Therefore, all participants were told they might receive an opportunity to smoke. Participants in the acceptance and suppression groups were reminded to use their coping strategy. The experimenter then left the room and administered instructions via intercom to remove the tray's cover, which revealed the participant's pack of cigarettes, a lighter, and an ashtray. Participants were asked to remove a cigarette from the pack and light it without raising it to their mouth. While holding the lit cigarette, they viewed a series of 12 smoking-related images, presented for 15 seconds each, on the computer monitor (pictures obtained from Carter et al., 2006). After the last image, participants were asked to rate their urge from 0 to 100 (i.e., verbal version of 1-Urge) and then extinguish the cigarette.

Part IV: Second (experimental) thought-recording period and time 2 outcome measures. Immediately following cue exposure, participants again recorded their thoughts about smoking for 3 minutes. Participants in the acceptance and suppression groups were told to continue using their assigned coping strategy (i.e., suppression group should suppress thoughts about smoking), whereas the control group was given the same instructions as at time 1. Immediately after the experimental thought-recording period, participants completed the QSU-4, ME, MF (state), 1-Discomfort, handgrip, and the second part of the manipulation check.

Part V: Third thought-recording period and time 3 outcome measures. To assess for rebound effects, all participants recorded their thoughts about smoking for 3 additional minutes but this time were given the same instructions as at time 1 (i.e.,

acceptance and suppression groups were told to disregard their assigned strategy) and then completed the QSU-4, ME, MF (state), 1-Discomfort, and BCT.

Part VI: Compensation, debriefing, and 3-day follow-up. Upon completion of the tasks described above, participants were told that the purpose of the study was to evaluate strategies for responding to craving and compensated $25 ($20 plus $5 for the BCT). All participants were asked to attempt to quit smoking for the next 3 days, as "practice" for their upcoming planned quit attempt, and given the tracking sheets to record the exact time that they smoked their first cigarette after leaving the laboratory and to tally the total number of cigarettes they smoked during the 3-day follow-up (see Appendix K). Participants in the acceptance and suppression groups were told to use their assigned coping strategy and given a small reminder card. The control group was not given any coping instructions. Participants were also given a set of follow-up questionnaires that they were instructed to complete at the end of Day 3 and then return via mail in a provided stamped envelope. Alternatively, they could complete the follow-up questionnaires electronically via http://www.surveymonkey.com. The follow-up questionnaires included the 1-SE, SET, 1-Discomfort (modified to reflect past 3 days), a modified version of the second part of the manipulation check that contained the same items but asked participants to rate the extent to which they used each strategy throughout the past 3 days, and an open-ended question asking them to describe any additional coping strategies they used. Participants who returned the follow-up questionnaires were mailed a $5 gift card to Walmart and entered into a lottery to win an additional $50 Walmart gift card. All participants also were mailed a copy of *Clearing the Air*, a self-help cessation guide (USDHHS & National Cancer Institute, 2008).

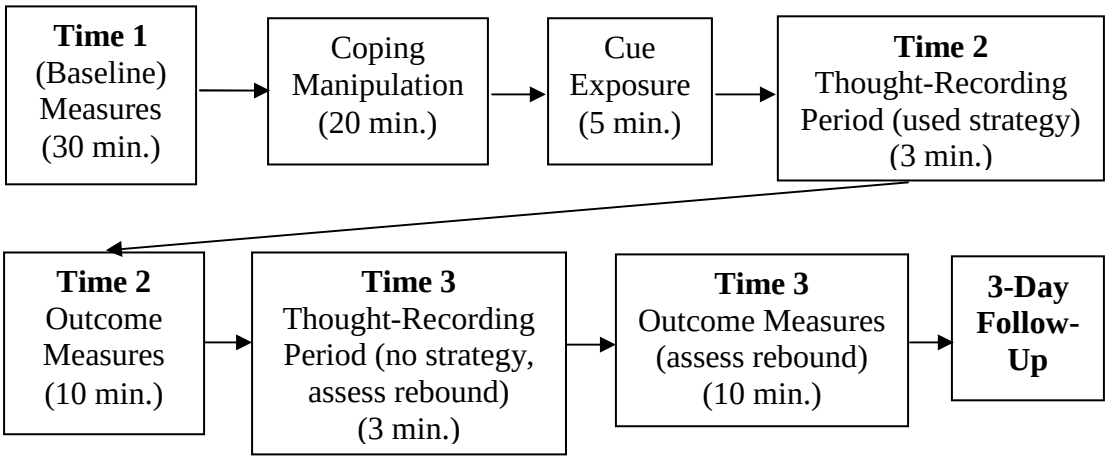

Figure 1. Study procedure.

Results

Data Analysis Plan

Power analysis. Using methods suggested by Cohen (1988), the sample size of 162 had a power of at least .80 to detect a medium effect size with an alpha of .05, two-sided. We chose to assume a medium effect size because smaller effect sizes may have little clinical or theoretical significance (Cohen, 1988). Regarding the follow-up data, we accepted that power would be somewhat reduced due to attrition.

Data screening. Participants were prompted to answer skipped questionnaire items if they were willing. Remaining missing items were imputed using the mean value of their responses to the other items on that scale, provided that at least 90 percent of the items were answered and the scale included at least 10 items. Otherwise, missing data were dropped.

All data were also screened for outliers and violations of parametric test assumptions (i.e., normal distribution, homoscedasticity). If an outlier was found (i.e., > 3 standard deviations from the mean), analyses were completed with the outliers, with outliers Windsorized to 1 integer value above the next highest value, and without the outlier(s), and these results compared. As expected, some degree of non-normality and heteroscedasticity was found and was determined acceptable given that parametric tests are considered robust to violations of these assumptions when the sample size is relatively large and equal in each group as it was in the current study.

Type I error. The alpha for the primary analyses was set at .05 (two-tailed). Because of the early stage of this line of research, and because the questions were theoretical rather than applied, we were as equally concerned with Type II error as Type I. Therefore, we did not correct for study-wise error when conducting a priori analyses on the primary outcome variables (Keppel, 1982). We did, however, use Bonferroni corrections for post-hoc tests associated with the primary analyses.

Primary and secondary analyses. All means reported are covariate-adjusted (baseline values of the dependent variables were covariates in all primary and secondary analyses). For each dependent variable, sets of two planned orthogonal contrasts consistent with the hypotheses were conducted. For specific aim 1 and the secondary aim, the first contrast compared the mean of the combination of the experimental groups (acceptance and suppression) to the control group, and the second contrast compared the acceptance group to the suppression group. The dependent variables for these contrasts included time 2 urge (1-Urge, QSU-4, ME) and affect (MF state, 1-Discomfort), and the follow-up measures (latency, total cigarettes smoked, 1-SE, 1-Discomfort, and SET). For specific aims 2 and 3, the first contrast compared the suppression group to the mean of the combination of the other two groups (acceptance and control), and the second contrast compared the acceptance group to the control group. The dependent variables for these contrasts included number of thoughts about smoking and handgrip squeeze duration (seconds) at time 2, and urge (QSU-4, ME), affect (MF state, 1-Discomfort), and the BCT at time 3.

Participant Characteristics

Demographics and baseline measures. Demographic characteristics are presented in Table 1 and baseline (time 1) measures are presented in Table 2 (note: outliers in number of quit attempts were dropped). Results of preliminary chi-square analyses and one-way analyses of variance (ANOVAs) suggested equivalence (i.e., successful randomization) among the three groups in demographics and most baseline measures (*p's* > .10). However, there were baseline differences among the groups (*p's* < .10) in cigarettes smoked per day and affective state. Primary outcome analyses were run with and without these variables as covariates; however, no differences were found and therefore results are presented without these covariates (i.e., only baseline values of dependent variables as covariates).

Smoking-Related Cognitions (SRC). Participants indicated that during their most recent quit attempt, they had strong urges to smoke and tried to suppress ideas about smoking (see Table 3). There were no significant differences in these cognitions among the groups (all *p's* > .10).

Attrition at 3-day follow-up. There was no significant difference among the groups in the number of participants who returned their follow-up data, χ^2 (2, 162) = .23, p = .89. The return rate was 69.8% (68.5% in acceptance, 72.2% in suppression, 68.5% in control).

Table 1

Participant Demographic Characteristics (Percentages)

Variable	Acceptance	Suppression	Control	Overall	*p*
N	54	54	54	162	
Age (mean and SD)	35.93 (11.71)	37.33 (11.31)	37.26 (11.57)	36.84 (11.48)	0.78
Gender (% male)*	50.0	50.0	50.0	50.0	1.0
Race					0.46
Caucasian	88.9	70.4	74.1	77.8	
Black	7.4	18.5	22.2	16.0	
Ethnicity					0.49
Hispanic	11.1	14.8	7.5	11.2	
Marital status					0.11
Single	55.6	50.0	31.5	45.7	
Living with partner	13.0	11.1	20.4	14.8	
Married	20.4	9.3	24.1	17.9	
Separated	3.7	5.6	1.9	3.7	
Divorced	5.6	22.2	20.4	16.0	
Widowed	1.9	1.9	1.9	1.9	
Education					0.91
< HS	13.0	11.1	9.3	11.1	
HS grad	20.4	25.9	27.8	24.7	
Some college	55.6	53.7	57.4	55.5	
≥ 4-yr degree	11.2	9.3	5.6	8.7	

*Randomization was stratified by gender, but no gender differences in the primary outcomes were found.

Table 2

Participant Baseline Characteristics (Means and Standard Deviations)

Variable	Acceptance	Suppression	Control	Overall	*p*
Years smoked	18.10 (12.04)	18.12 (10.56)	19.37 (11.55)	18.53 (11.34)	0.80
Cigarettes per day*	**19.06 (6.28)**	**19.10 (8.09)**	**22.14 (10.20)**	**20.10 (8.42)**	**0.09**
FTND score	5.19 (2.07)	5.19 (2.12)	5.61 (2.33)	5.33 (2.17)	0.50
CO (ppm)	22.41 (11.44)	20.83 (12.28)	23.63 (11.21)	22.29 (11.64)	0.46
Lifetime quit attempts (#)	7.97 (16.29)	10.37 (19.96)	6.23 (14.44)	8.16 (16.71)	0.45
Longest quit (Days)	299.17 (422.82)	360.00 (950.53)	214.83 (419.76)	291.29 (647.56)	0.51
Past year quit attempts (#)	1.40 (1.61)	1.22 (1.67)	0.97 (1.09)	1.20 (1.48)	0.33
Longest past year quit (Days)	7.80 (15.88)	5.27 (9.13)	5.91 (11.49)	6.33 (12.47)	0.57
QSU-4	23.24 (5.65)	24.20 (4.43)	22.88 (6.25)	23.45 (5.48)	0.44
One-Item Urge (0-100)	66.19 (28.58)	76.08 (24.12)	71.63 (26.60)	71.30 (26.64)	0.16
One-Item Discomfort (0-100)	53.58 (28.32)	56.08 (32.84)	59.41 (29.89)	56.32 (30.30)	0.62
Trait Positive Affect	16.94 (5.56)	17.48 (5.36)	17.07 (5.37)	17.17 (5.40)	0.87
Trait Negative Affect	18.44 (7.40)	18.61 (7.82)	19.74 (6.96)	18.93 (7.38)	0.62
State Positive Affect	**13.65 (5.82)**	**11.94 (4.52)**	**11.30 (5.25)**	**12.30 (5.28)**	**0.06**
State Negative Affect	**10.28 (5.88)**	**12.26 (6.28)**	**12.94 (7.09)**	**11.82 (6.49)**	**0.09**
One-Item Self-Efficacy (SE) (0-100)	37.27 (25.01)	33.24 (29.45)	35.13 (26.48)	35.19 (26.95)	0.75
SE-Positive Affect/Social Situations	15.00 (5.17)	14.00 (4.610	15.15 (5.27)	14.72 (5.02)	0.45
SE-Negative Affect Situations	10.89 (4.05)	10.54 (3.99)	9.93 (3.86)	10.45 (3.96)	0.45
SE-Habitual/Craving Situations	18.31 (5.20)	17.75 (5.00)	16.75 (6.00)	17.60 (5.43)	0.33
Thoughts about Smoking (3 min.)	3.78 (2.58)	5.81 (9.36)	5.69 (4.19)	5.09 (6.11)	0.15
Handgrip (seconds)	69.87 (44.04)	72.67 (44.58)	65.85 (48.57)	69.46 (45.57)	0.74

*Four participants reported a smoking rate of less than 10 cigarettes per day on the SSQ (range 6.5-9; All had reported 10 or more during initial phone/online screening). These participants met all other inclusion criteria and were allowed to complete the study. Results of primary analyses did not change if these individuals were excluded, with one minor exception described in Footnote 2.

Table 3

Smoking-Related Cognitions During Most Recent Quit Attempt (0-100)

Cognition	Acceptance	Suppression	Control	Overall	*p*
How pleasant was the idea of having a cigarette?	62.94	61.24	66.3	63.48	0.63
How much did you try to suppress ideas about smoking?	71.85	64.20	67.94	68.00	0.26
How strong was your urge to smoke?	71.56	67.48	69.35	69.46	0.7
How able to resist the idea of smoking did you feel?	47.44	46.87	52.39	48.90	0.43
How strong was the urge to distract yourself from the idea of smoking in some way?	65.30	63.13	63.20	63.88	0.88
How in control of ideas about smoking did you feel?	44.50	40.52	46.63	49.99	0.46
How acceptable did you find the idea of smoking?	54.15	44.35	50.98	49.83	0.12
How uncomfortable did ideas about smoking make you?	51.19	52.17	46.63	49.99	0.52
How much did you think you would become relaxed if you had a cigarette?	73.43	71.46	74.13	73.01	0.85

Manipulation Checks

Quiz. A one-way ANOVA revealed no significant differences among the groups in participants' perception of how interesting the presentations were, p =.28. An additional ANOVA revealed no significant difference between the acceptance (M = 3.43, SD = .74) and suppression (M = 3.39, SD = .90) groups in participants' expectations of the usefulness of their assigned strategy, p = .82. However, regarding memory and comprehension of the presentations, more participants in the acceptance group did not pass the quiz (n = 15, 27.8%) than in the suppression (n = 1, 1.9%) and control (n = 4,

7.4%) groups, χ^2 (2, N = 162) = 18.60, p < .001.[1] Additionally, a one-way ANOVA showed that the acceptance group (M = 3.94, SD = .71) reported that they understood the presentation somewhat less well than the suppression (M = 4.48, SD = .72) and control groups (M = 4.48, SD = .75), F(2, 159) = 9.85, p < .001.

Laboratory session: strategies used. There was no significant difference between the acceptance (M = 3.59, SD = .74) and suppression (M = 3.64, SD = .90) groups in ratings of usefulness of their assigned strategy, p = .76. However, as expected, ANOVAs revealed significant differences among the groups on the acceptance, F(2, 159) = 13.76, p < .001, and suppression, F(2, 159) = 29.27, p < .001, subscales that assessed the extent to which participants used those respective strategies. Post-hoc Tukey's tests indicated that the acceptance group scored significantly higher on the acceptance subscale (M = 16.80, SD = 3.84) than the suppression (M = 12.81, SD = 4.75) and control (M = 13.37, SD = 4.18) groups, both p's < .001. The suppression and control groups did not differ, p = .78. On the suppression subscale, the suppression group (M =17.31, SD = 5.27) scored significantly higher than the control group (M = 12.17, SD = 5.83) and the acceptance group (M = 9.43, SD = 5.20), both p's <.001. Also, the control group scored significantly higher than the acceptance group, p = .03.

The control group's responses to the open-ended question that asked them to describe how they responded to their craving during the experimental tasks (cue exposure and experimental thought-recording period) were classified into categories by two independent raters. Discrepancies regarding categories were resolved through discussion until a final group of 9 categories was identified. All responses were then independently

[1] Very few differences were found in results of primary analyses when only those participants who passed the quiz were included. See Footnotes 3 and 4.

re-coded by the two raters into these 9 categories, with participants assigned to multiple categories when warranted. Initial agreement after this re-coding was 81%, and remaining discrepancies were again resolved through discussion. The final coding revealed that 20.4% did not specify a coping strategy and reported that they experienced craving but not negative affect, 20.4% tried to suppress thoughts of smoking, 18.5% did not specify a strategy and reported that they experienced craving and negative affect, 18.5% distracted themselves by thinking about something other than smoking, 7.4% tried to distract themselves with physical movement (e.g., shaking leg), 5.6% focused their thoughts on the possible opportunity to smoke later, and 13.0% reported that they did not experience craving or gave an ambiguous response.

Follow-up: strategies used. Regarding participants' perceptions of how useful their respective assigned strategies were during follow-up, there was no significant difference between the acceptance (M = 3.46, SD = 1.01) and suppression groups (M = 3.16, SD = .96), p = .21. However, as expected, there were significant differences among the groups on the acceptance subscale, $F(2, 108) = 14.40$, $p < .001$. Post-hoc Tukey's tests indicated that, consistent with results from the laboratory session, the acceptance group scored significantly higher on the acceptance subscale (M = 15.05, SD = 4.63) than the suppression (M = 9.92, SD = 4.45) and the control (M = 10.57, SD = 4.36) groups, both p's < .001. The suppression and control groups did not differ from each other, p = .81. However, there was only a trend towards a significant difference among the groups on the suppression subscale, $F(2, 108) = 2.40$, p = .09. The means on the suppression subscale at follow-up vs. during the laboratory session (acceptance M = 10.11 vs. 9.43, suppression M = 12.81 vs. 17.31, control M = 11.03 vs. 12.17) suggest that the

suppression group exerted less effort to suppress during follow-up than during the laboratory session.

Effect of Coping Manipulation at Time 2

Craving. As predicted (hypothesis 1a), the combined acceptance and suppression groups reported less craving than the control group on all three craving measures (1-Urge, QSU-4, and ME) (all *p's* < .05). However, contrary to hypothesis 1b, the acceptance and suppression groups did not differ on the 1-Urge or ME (*p's* > .05), and the suppression group reported less urge than the acceptance group on the QSU-4, $t(154) = 2.00$, $p = .05$ (see Table 4).[2]

Affect. As predicted (hypothesis 1a), the combined acceptance and suppression groups reported greater positive affect, $t(156) = -2.70$, $p = .008$, and less negative affect, $t(156) = 2.56$, $p = .01$, than the control group; however, contrary to hypothesis 1b, the acceptance and suppression groups did not differ (*p's* > .05) (see Table 5). Contrary to hypotheses 1a and 1b, neither planned contrast was significant (*p*'s > .05) for the 1-Discomfort measure (see Table 4).

Number of thoughts about smoking. As predicted (hypothesis 2a), the suppression group reported fewer thoughts than the combined acceptance and control groups, $t(157) = -3.98$, $p < .001$. However, the acceptance group also reported fewer thoughts than the control group, $t(157) = -2.81$, $p = .006$ (see Table 4).

Self-control (handgrip). Contrary to prediction (hypothesis 2b), neither planned contrast was significant (*p's* > .05) (see Table 4).

[2] When participants who reported smoking fewer than 10 cigarettes per day were excluded, this difference was reduced to a trend, $p = .09$.

Effect of Coping Manipulation at Time 3 - Rebound Effect for Suppression Group?

Craving. Contrary to hypotheses 3a and 3b, the suppression group reported significantly less, not more, craving than the combination of the acceptance and control groups on the QSU-4, $t(156) = -3.08$, $p = .002$, and there was no significant difference between the acceptance and control groups, $t(156) = -1.24$, $p = .22$. Additional post-hoc simple main effects tests with Bonferroni correction revealed a significant difference between suppression and control, $p = .004$, but no significant difference between acceptance and suppression, $p = .12$, on the QSU-4. On the ME, there was no significant difference between the suppression group and the combination of the acceptance and control groups ($p = .38$); however, as hypothesized (3b), the acceptance group reported significantly less ME urge than the control group, $t(159) = -2.96$, $p = .004$. The means for the ME suggested that the planned contrasts were not sufficient to describe the pattern of results; therefore, Tukey's post-hoc tests were also conducted to compare all sets of groups. These post-hoc tests indicated that the suppression and acceptance groups did not differ from each other, $p = .75$. The acceptance group reported significantly less urge than the control group, $p = .01$, but there was only a trend for the suppression group to report significantly less ME urge than the control group, $p = .07$ (see Table 4). Taken together, these results suggest the suppression group did not experience a rebound effect in craving.

Affect. Contrary to prediction (hypothesis 3a), the suppression group reported less, not more, discomfort than the combination of the acceptance and control groups, $t(148) = -1.97$, $p = .05$. However, as hypothesized (3b), the acceptance group reported

less discomfort than the control group, $t(148) = -2.21$, $p = .03$. An additional post-hoc test with Bonferroni correction indicated no significant difference between the acceptance and suppression groups, $p > .05$ (see Table 5). Regarding positive and negative affect, none of the planned contrasts were significant (*p's* > .05). Taken together, these results suggest that no rebound effects in affect occurred in the suppression group (see Table 4).

Number of thoughts about smoking and behavioral choice task. None of the planned contrasts for number of thoughts about smoking or the behavioral choice task were significant (*p's* > .05), suggesting that no rebound effects occurred (see Table 4).

Table 4

Covariate-Adjusted Means and Standard Errors for Primary Analyses

	Time 2			Time 3		
Outcome	Acceptance	Suppression	Control	Acceptance	Suppression	Control
Craving						
One-Item (0-100)	64.35 (3.02)	66.99 (3.02)	77.31 (3.02)[aa]	N/A	N/A	N/A
QSU-4	21.91 (.73)	19.85 (.73)[b]	24.05 (.74)[aaa]	22.08 (.73)	19.96 (.73)[c]	23.36 (.74)
Magnitude						
Estimation (ME)*	14.02 (10.95)	12.34 (9.04)	21.76 (17.34)[aaa]	14.02 (8.65)[d]	15.94 (17.14)	21.86 (14.17)
Affect						
Positive Affect	12.59 (.41)	12.67 (.41)	11.26 (.42)[aa]	11.73 (.42)	11.99 (.41)	10.97 (.42)
Negative Affect	10.03 (.56)	11.22 (.56)	12.39 (.56)[aa]	10.45 (.61)	10.45 (.61)	11.97 (.62)
Discomfort (0-100)	54.49 (3.61)	60.43 (3.60)	63.95 (3.72)	54.73 (3.67)	51.55 (3.74)	66.31 (3.74)[a]
Thoughts about						
Smoking (#)	5.72 (.80)[d]	3.40 (.80)	8.90 (.80)[aaa]	9.04 (2.08)	10.06 (2.09)	5.87 (2.07)
Handgrip (seconds)	54.62 (3.29)	48.46 (3.32)	52.03 (3.29)	N/A	N/A	N/A
Behavioral Choice						
Task ($)*	N/A	N/A	N/A	7.23 (9.00)	8.69 (9.91)	9.22 (10.34)

*Not covariate-adjusted because there was no baseline value. Standard deviation shown in parentheses.
Significant difference between control and other groups, [a]$p \leq .05$, [aa]$p \leq .01$, [aaa]$p \leq .001$
Significant difference between suppression and acceptance, [b]$p = .05$
Significant difference between suppression and other groups, [c]$p \leq .01$
Significant difference between control and acceptance, [d]$p \leq .01$

Three-Day Follow-Up

Latency to smoke. The maximum latency was 84 minutes, with the exception of 5 outliers who were between 165-269 minutes (1 in acceptance, 2 in suppression, 3 in control). The analysis was run with these outliers deleted, with them Windsorized to 85 minutes, and with them included. With outliers deleted, consistent with hypothesis 4a the mean latency of combination of the acceptance and suppression groups was significantly longer than the control group, $t(81) = -2.17$, $p = .03$,[3] but contrary to hypothesis 4b the acceptance and suppression groups did not differ, $p = .95$ (see Table 5). However, none of the planned contrasts with the outliers Windsorized or included were significant (all *p's* > .05).

Total cigarettes smoked and discomfort. None of the planned contrasts were significant (all *p's* > .05), indicating no significant differences among the groups in total cigarettes smoked or discomfort during follow-up (see Table 5).

Self-efficacy. As predicted (hypothesis 4a), at follow-up the combination of acceptance and suppression groups reported significantly greater confidence that they could quit smoking for one year (1-SE) and avoid smoking in habitual and craving situations (HCS) (subscale of SET) compared to the control group (both *p's* < .05). However, contrary to hypothesis 4b, there was no significant difference between the acceptance and suppression groups on either self-efficacy measure (see Table 5). Also, none of the planned contrasts for the other two subscales of the SET (positive affect and social situations[4], negative affect situations) were significant (all *p's* > .05) (see Table 5).

[3] When only participants who passed the quiz were included, this difference was reduced to a trend, $p = .06$
[4] When only participants who passed the quiz were included, both contrasts for positive affect and social situations were significant (control vs. all others, $p = .02$, acceptance superior to suppression, $p = .03$).

Table 5

Covariate-Adjusted Means and Standard Errors for Secondary Analyses

Secondary Outcome	Acceptance	Suppression	Control
Latency to Smoke (Minutes)*	19.19 (19.08)	18.87 (23.43)	9.00 (15.50)[a]
Total Cigarettes Smoked	39.03 (2.82)	41.49 (2.70)	39.33 (2.84)
Discomfort (0-100)	42.92 (4.28)	42.80 (4.14)	41.00 (4.44)
Self-Efficacy			
1 Year of Abstinence (0-100)	45.06 (4.54)	53.23 (4.46)	36.21 (4.35)[a]
Habitual/Craving Situations (HCS)	19.85 (.74)	19.65 (.75)	16.87 (.75)[a]
Positive Affect/Social Situations (PASS)	16.92 (.69)	16.37 (.73)	15.34 (.68)
Negative Affect Situations (NAS)	12.62 (.69)	13.31 (.69)	11.61 (.70)

*5 outliers above 84 minutes deleted. Not covariate-adjusted because there was no baseline value. Standard deviation shown in parentheses.
[a]Significant difference between control and other groups, $p < .05$

Other coping strategies used. Responses to this open-ended question were classified into categories by two independent raters. Discrepancies regarding categories were resolved through discussion until a final group of 10 categories was identified. Despite instructions to participants to exclude acceptance or suppression, a few stated these strategies anyway and they were included in the final categories. All responses were then independently re-coded by the two raters into these 10 categories, with participants assigned to multiple categories when warranted. Initial agreement after re-coding was 76%, and remaining discrepancies were again resolved through discussion.

The final coding was as follows: behavioral or non-caloric oral distraction (e.g., watching TV or chewing gum, 31.9%), deliberately changing pattern of smoking or availability of cigarettes (e.g., only smoking at specific times, not smoking in certain

rooms of their home, going to places where smoking wasn't allowed, 23.9%), eating caloric food (12.4%), thinking about the benefits of cessation or the negative consequences of smoking (11.5%), physical activity (11.5%), thought distraction (i.e., thought about something unrelated to smoking, 10.6%), thought suppression (i.e., suppressed thoughts about smoking, 9.7%), and acceptance-based strategies (4.4%). Finally, 15.0% of participants explicitly reported that they did not experience craving or continued to smoke as usual. Exploratory chi-square analyses were conducted to determine if there were any significant differences among the groups in strategies reported. These analyses revealed that more participants in the acceptance condition (13.5%) reported acceptance than in the other two groups (0% in suppression, 0% in control), χ^2 (2, 113) = 10.75, p =.005, and more participants in the suppression group (23.1%) reported eating caloric food than in the other two groups (8.1% in acceptance, 5.4% in control), χ^2 (2, 113) = 6.39, p = .04.

Exploratory Moderation Analyses

A recent study suggested that acceptance-based coping may convey greater benefit than control-based coping for individuals who tend to struggle with cravings, and vice versa for those less susceptible to cravings (Forman et al., 2007). Given that we found no main effects when comparing acceptance versus suppression, we conducted exploratory moderation analyses to examine whether the effects of the coping manipulation on urge and affect were moderated by smoking rate (i.e., cigarettes per day) or level of nicotine dependence (i.e., FTND score), which may capture variability in tendency to struggle with craving. We predicted that acceptance would have greater benefit for heavier, more dependent smokers, and vice versa for suppression. General

linear models were used with time 2 urge (1-Urge, QSU-4, ME) and affect (MF state) as the dependent variables, group as the independent variable, baseline (time 1) urge and affect as covariates, cigarettes per day or FTND as an additional covariate, and an interaction term between cigarettes per day or FTND and group. Planned contrasts were conducted to compare the slopes of the acceptance and suppression groups (i.e., to determine if the relationship between smoking rate or FTND and craving or affect differed by group).

Craving. There were no significant moderation effects for the 1-Urge measure. However, smoking rate significantly moderated the effect of group (i.e., slopes for acceptance and suppression differed) on the QSU-4, $t(153) = 2.24$, $p = .03$. To determine the nature of this effect, a scatterplot with cigarettes per day on the x axis and QSU-4 (adjusted for time 1) on the y axis with the best-fitting line shown for each group was examined visually. Partially consistent with prediction, there was a positive relationship between smoking rate and QSU-4 in the suppression group, but no relationship in the acceptance group. Additionally, a significant crossover moderation effect of smoking rate was found for the ME, $t(156) = 1.96$, $p = .05$, such that the relationship between smoking rate and ME was positive in the suppression group, but negative in the acceptance group (see Figure 2).

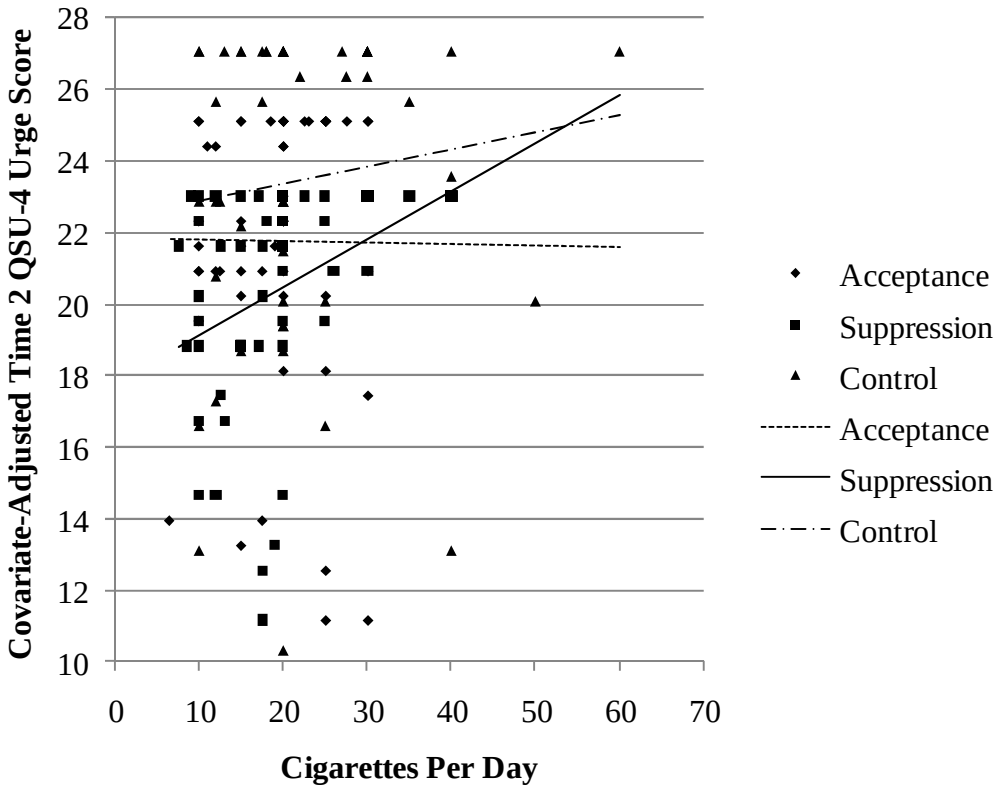

Figure 2. Smoking rate by group interaction effect for QSU-4 urge.

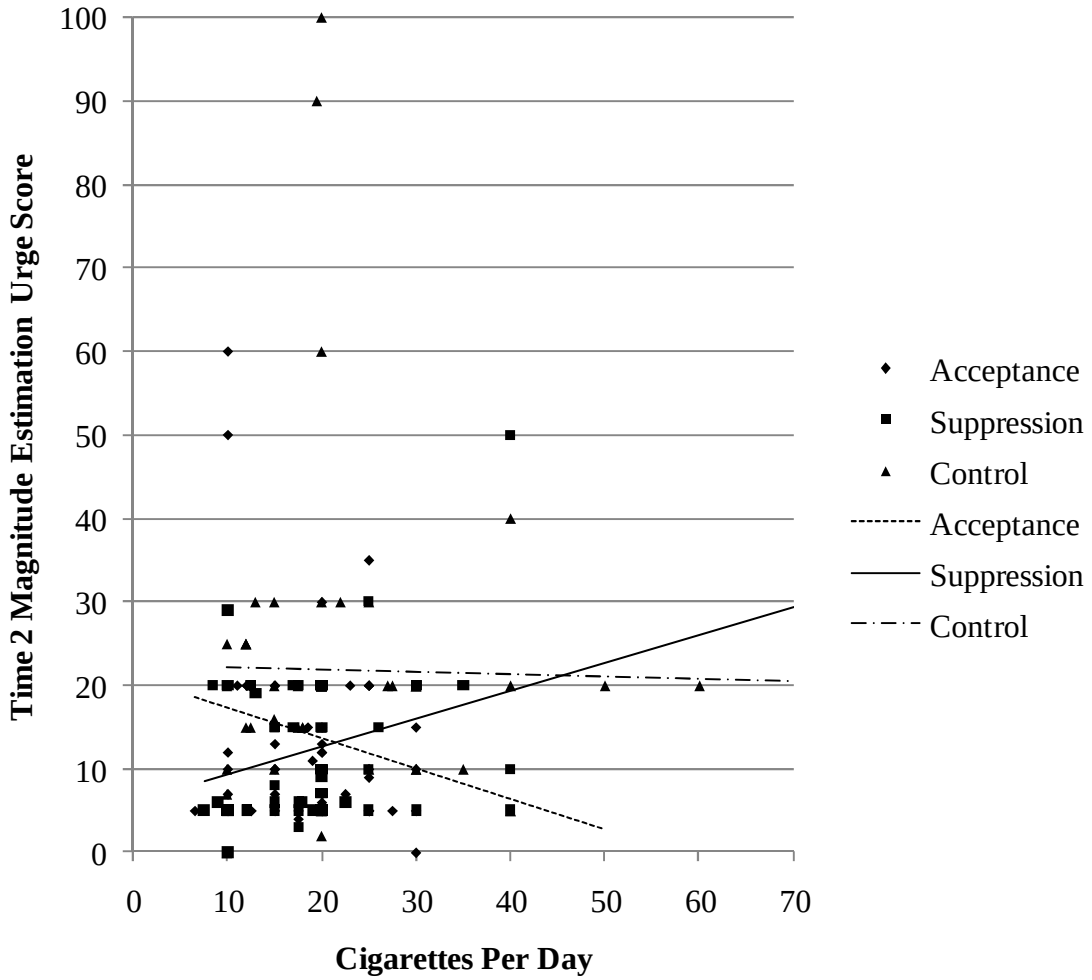

Figure 3. Smoking rate by group interaction effect for Magnitude Estimation urge.

Affect. Smoking rate moderated the effect of group on NA, $t(154) = 2.12$, $p = .04$. Additionally, FTND significantly moderated the effect of group on negative affect (NA), $t(154) = 2.95$, $p = .004$, and positive affect (PA), $t(153) = -2.36$, $p = .02$. Scatterplots revealed a positive relationship between NA and smoking rate, and between NA and FTND, in the acceptance group, but there appeared to be no relationship between NA and smoking rate or FTND in the suppression group (see Figure 3). Furthermore, acceptance appeared to convey greater benefit than suppression (i.e., was associated with less NA)

for lighter, less dependent smokers, but there appeared to be no difference in NA between acceptance and suppression in heavier, more dependent smokers. For PA, the scatterplot suggested no relationship between FTND and PA in the acceptance group, but a negative relationship in the suppression group. Additionally, suppression seemed to convey less benefit (i.e., was associated with lower PA) in more dependent smokers, but there appeared to be no difference in PA between acceptance versus suppression in less dependent smokers (see Figure 4).

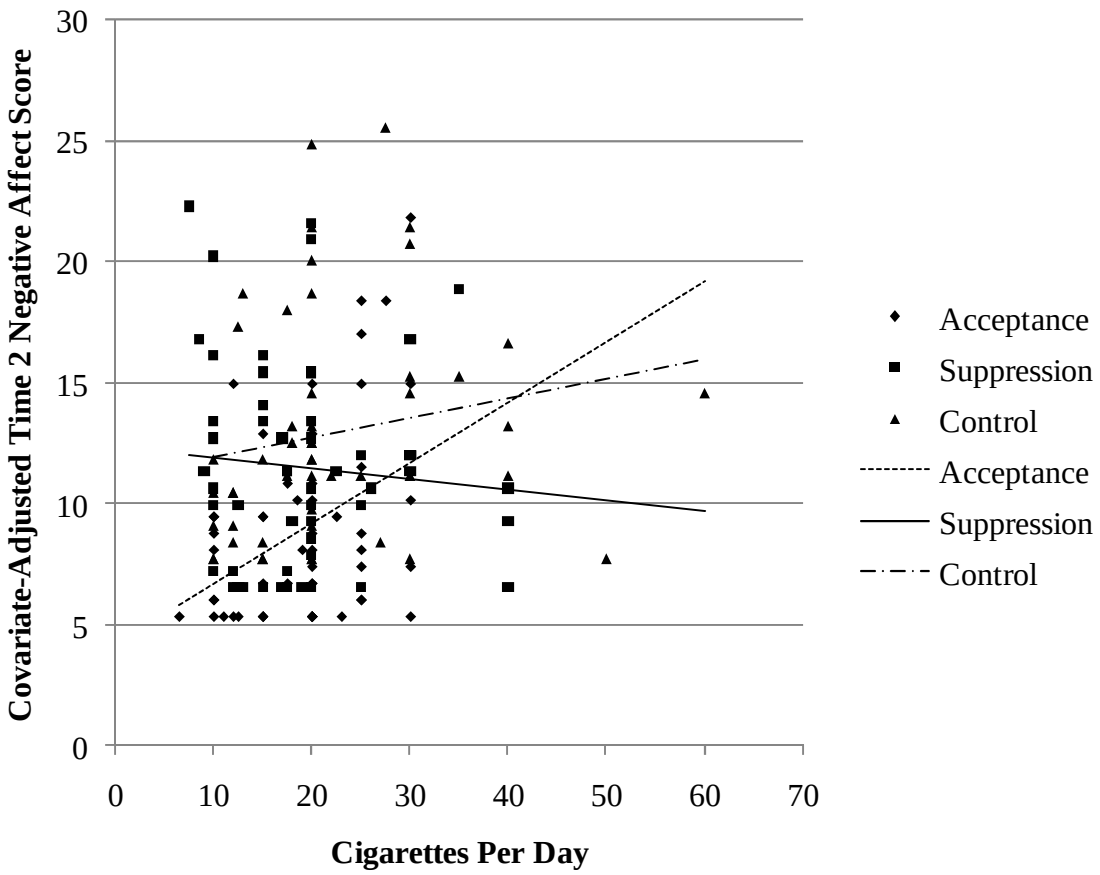

Figure 4. Smoking rate by group interaction effect for Negative Affect (NA).

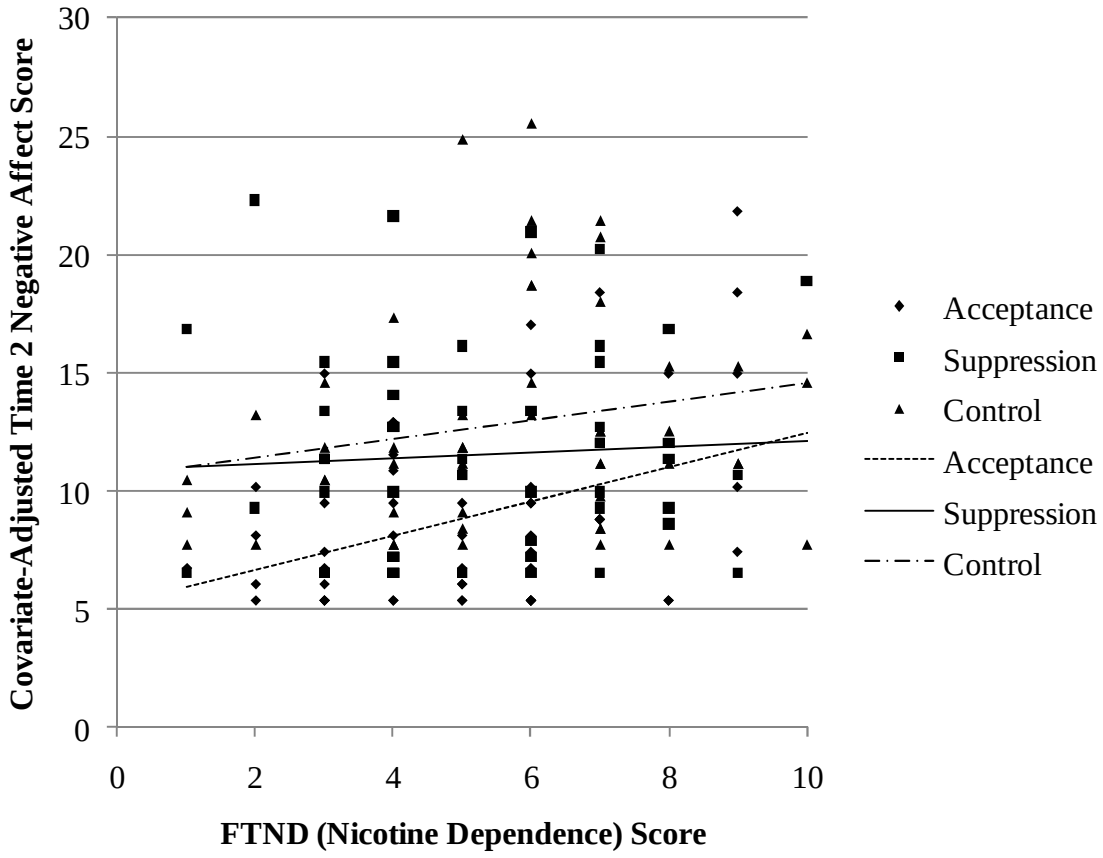

Figure 5. FTND by group interaction effect for Negative Affect (NA).

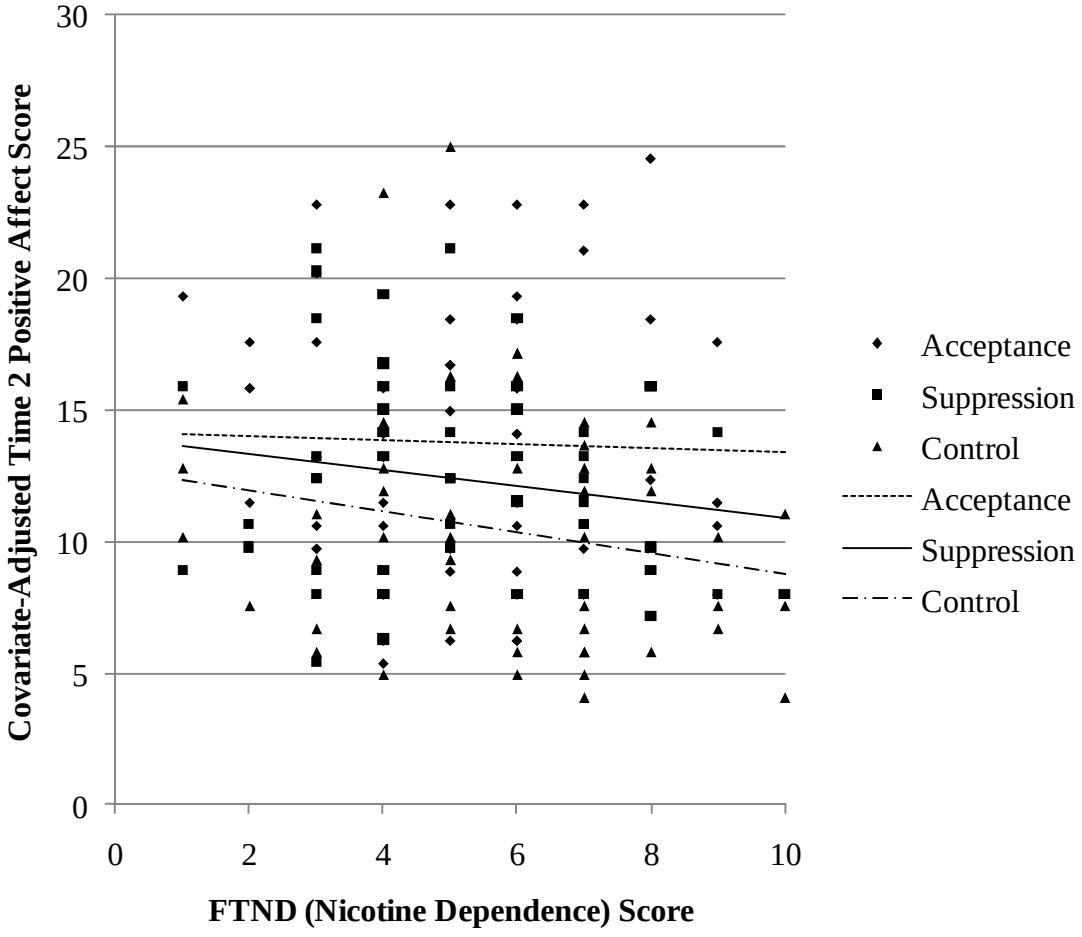

Figure 6. FTND by group interaction effect for Positive Affect (PA).

Discussion

Most psychological treatments for substance use disorders consist primarily of skills for preventing and responding to craving. The primary goal of the current study was to compare the use of acceptance-based coping from Acceptance and Commitment Therapy (ACT) (Hayes et al., 2003) to suppression, an intuitive, commonly used (Salkovskis & Reynolds, 1994) coping strategy proscribed in ACT. Adult smokers with a desire to quit smoking within six months were randomized to acceptance, suppression, or no coping instructions (control group) to cope with cigarette craving induced via cue exposure and then attempted to quit for three days. It was hypothesized that both acceptance and suppression would be somewhat effective coping strategies, but that acceptance would be superior and suppression would result in depletion of self-control and a counterproductive rebound effect.

Results indicated that participants in the experimental conditions (acceptance and suppression) reported less intense craving, greater positive affect, and less negative affect during the laboratory session as compared to the control group; however, acceptance was not superior to suppression. Although the suppression group was somewhat successful at suppressing thoughts of smoking relative to the other groups, they did not appear more depleted in self-control nor did they experience any rebound effects. The experimental groups waited longer to smoke their first cigarette after leaving the laboratory and at 3-day follow-up reported greater self-efficacy for cessation compared to the control group,

but did not differ from each other. Finally, there was no significant difference among the groups in number of cigarettes smoked during the three days after the laboratory session. Exploratory moderation analyses suggested that the effects of acceptance-based and suppression-based coping on craving and affect may vary according to smoking rate and level of nicotine dependence. Regarding craving, it appeared as though suppression was more beneficial for lighter smokers, whereas there was no difference or perhaps a slight advantage for acceptance in heavier smokers. Regarding affect, results indicated that suppression was associated with greater negative affect (NA) than acceptance among lighter and less dependent smokers, but less positive affect (PA) than acceptance among more dependent smokers. There appeared to be no group differences in NA among heavier, more dependent smokers, or in PA among less dependent smokers. Taken together, the results of the current study suggest that acceptance-based coping strategies have some value among smokers who desire to quit, but do not support the theorized general superiority of acceptance over suppression.

Manipulation Check

As expected, during the laboratory session the acceptance group reported that they used acceptance more than suppression, with the expected opposite pattern for the suppression group. Nevertheless, we cannot rule out the possibility that these results could be attributable to a demand effect and not to actual differences in how participants were responding to their craving. Future research may consider incorporating technology such as brain imaging techniques (e.g., fMRI), which may offer potential insights into cognitive coping processes (e.g., Kross, Davidson, Weber, & Ochsner, 2009; Rauch et al., 2007), and provide a more objective manipulation check. For example, Hartwell et

al. (2011) reported that smokers' use of distraction versus thinking about the negative consequences of smoking to cope with cue-induced craving during an fMRI scan could be distinguished by differing patterns of activation.

Novelty and Difficulty of Acceptance Versus Suppression

Although we adapted intervention scripts used successfully in previous studies (Forman et al., 2007; Levitt et al., 2004), participants in the acceptance group had more difficulty understanding their less intuitive strategy as compared to the suppression group. Therefore, we may have failed to find that acceptance was superior to suppression because our intervention was too brief for participants to achieve competence in implementing acceptance. Notably, our sample was older and more diverse than Levitt et al. (2004), and lower in education level and socioeconomic status than Forman et al. (2007), whose participants were college students.

Heterogeneity in Existing Suppression Literature

Dunn, Billotti, Murphy, and Dalgleish (2009) argue that although the current clinical "zeitgeist" proscribes suppression because of its supposed ineffectiveness (i.e., "maladaptive suppression hypothesis") and recommends acceptance-based coping as the superior alternative, in reality the empirical findings on thought suppression are "more mixed than generally recognized" (p. 762). Meta-analyses (e.g., Abramowitz et al., 2001) mask significant heterogeneity in the data, as there are numerous examples of studies that have not found rebound effects. As previously noted, laboratory studies have shown acceptance to be superior to suppression and other "control-based" techniques associated with CBT in coping with panic and anxiety (e.g., Levitt et al., 2004) and pain (Gutierrez, Luciano, Rodriguez, & Fink, 2004; Hayes et al., 1999). However, a clear

advantage for acceptance-based coping has not been found in laboratory studies investigating depression (Liverant, Brown, Barlow, & Roemer, 2008), tinnitus (Westin, Hayes, & Andersson, 2008), felt emotion in a non-clinical population (Dunn, Billotti, Murphy, & Dalgleish, 2009), and, most relevant to the current study, acceptance was not superior in increasing distress tolerance in smokers (Murray, 2007). Additionally, a recent study comparing acceptance and suppression in smokers found no differences between acceptance and suppression in smoking behavior or self-efficacy at a 7-day follow-up, which is consistent with the current results. However, only acceptance was associated with reduced negative affect, depressive symptoms, and nicotine dependence, none of which were assessed at follow-up in the current study (Rogojanski, Vettese, & Antony, in press). Also, acceptance was superior to CBT-based coping with chocolate craving only among individuals who often struggled with chocolate craving, whereas the opposite was found for individuals who were less susceptible to chocolate craving (Forman et al., 2007).

Short-term versus long-term efficacy. Our results suggest that suppression was somewhat effective, at least in the short-term. However, perhaps suppression can only be sustained for a limited duration of time before depletion or inevitable distractions occur and promote the counterproductive rebound effect. Distractions may increase cognitive load, which reduces individuals' capacity to suppress (e.g., Wegner & Erber, 1992). Indeed, our data offer some evidence that suppression was more difficult to sustain than acceptance. At follow-up, there was no significant difference among the groups in the extent to which suppression was used because the suppression group reported less effort to suppress than during the laboratory session. Also, more suppression participants

reported that they ate food to cope with craving during follow-up, which can be interpreted as evidence of self-control depletion and has potential implications for smoking cessation treatments given many smokers' concerns about weight gain (Hendricks, Wood, & Hall, 2009).

On the other hand, research suggests that over the long-term, the capacity of the self-control "muscle" can be increased through practice (e.g., Muraven, 2010a; Muraven, Baumeister, & Tice, 1999). For example, practicing self-control tasks unrelated to smoking cessation increases success at smoking cessation (Muraven, 2010b). It would be reasonable to assume that our participants, most of whom had a history of multiple quit attempts, would be well-practiced in suppression of cigarette craving. Furthermore, a recent study reported that engaging in suppression of smoking-related thoughts indeed reduced cigarette smoking in the short-term (1 week) but also resulted in a rebound effect in smoking the following week when participants stopped suppressing (Erskine, Georgiou, & Kvavilashvili, 2010). The authors concluded that suppression is so commonly used *because* it works in the short-term and people are unlikely to attribute rebound effects to suppression because of the time that has elapsed. Future studies should more systematically evaluate the effectiveness of suppression over time relative to practice and other variables that may influence how long it can be sustained.

Individual differences. Our exploratory moderation analyses, which must be interpreted with caution, suggested that the effects of acceptance versus suppression may vary according to smoking rate and level of nicotine dependence. If we assume that smoking rate and dependence capture variability in susceptibility to craving, our findings are somewhat consistent with Forman et al. (2007). More specifically, it appeared as

though lighter and/or less dependent smokers derived greater benefit with regard to reducing craving via the use of suppression relative to acceptance, but at the cost of greater negative affect. Perhaps because they likely experience fewer smoking-related intrusive thoughts and feelings, suppression is easier for lighter, less dependent smokers, but such successful suppression comes at the cost of increased negative affect, which has been associated with suppression in previous studies (e.g., Marcks & Woods, 2005).

It is possible that other unmeasured individual difference variables are also producing moderating effects in the current study, contributing to the overall finding of equivalence between acceptance and suppression. The current study focused on suppression of thoughts about smoking, but other types of suppression have also been studied, for example, suppression of undesirable or forbidden movements, which has practical applications for athletics. A review of this literature suggests that there are individual differences in ability to suppress and responding to suppression instructions. Russell and Grealy (2010) conducted an elegant experimental study to demonstrate that participants could be grouped according to the types of movement errors they typically made. Those who tended to make ironic errors (i.e., moving left when told not to move left) reported higher state and trait anxiety than those who tended to make overcompensatory errors (i.e., moving right when told not to move left). More relevant to the current study are the previously described findings of Forman et al. (2007) and a recently published study comparing brief acceptance and suppression interventions for cigarette craving (Rogojanski, Vettese, & Antony, 2011). Rogojanski et al. (2011) reported that higher state symptom-focused anxiety (fear of physical sensations associated with anxiety such as dizziness) immediately after the intervention was

associated with greater self-efficacy for cessation at 7-day follow-up in the suppression condition, but decreased self-efficacy in the acceptance condition. Future research should continue to examine these and other possible moderators.

Self-Control Performance

Our results revealed no differences in handgrip squeeze duration among the groups, suggesting that the suppression group was not more depleted. Unfortunately, with our data it is not possible to determine whether the acceptance and control groups were also depleted or whether no depletion occurred and the observed decrease in stamina from baseline to post-cue exposure among all the groups can be attributed to residual hand fatigue associated with the baseline measurement. Previous studies (e.g., Muraven & Shmueli, 2006; Muraven et al., 1998) have not measured handgrip squeeze at baseline.

Handgrip squeeze duration is a measure of physical stamina, but depletion has also been detected with other types of tasks including duration of persistence on frustrating cognitive tasks (e.g., unsolvable anagrams) (Muraven et al., 1998), suppression of facial expressions (Muraven et al., 1998), proneness to favor passive vs. active responses (Baumeister, Bratslavsky, Muraven, & Tice, 1998), and mirror tracing (Heckman, Ditre, & Brandon, in press). Therefore, we cannot rule out the possibility that the suppression group would have shown evidence of greater depletion than the other groups if a different task had been used. Also, as already mentioned, similar to exertion of muscles, self-control exertion results in depletion in the short-term but continued exertion builds strength over the long-term (e.g., Muraven, 2010a; Muraven, 2010b). Given that our participants were likely well-practiced in suppression of cigarette craving,

it is possible that the duration of suppression during the laboratory session (6 minutes) was not long enough to result in depletion.

Additionally, research has indicated that the depletion effect may be moderated by motivation. For example, depletion may be reduced or eliminated if individuals believe that their performance will benefit others or themselves (Muraven & Slessareva, 2003). Unlike the social drinkers in Muraven and Schmueli's 2006 study, who had no reason to believe that the purpose of the study was related to alcohol treatment, all participants in the current study were aware of the focus on smoking cessation. Therefore, although the handgrip task had no ostensible relationship to cessation, participants' belief that the study results could ultimately help themselves or others quit may have provided enough motivation to overcome the depleting effect of suppression.

Lack of Effect on Smoking Behavior

Both coping strategies appeared to have equal impact on subjective experience during the laboratory session, latency to smoke following the laboratory session, and self-efficacy for cessation, but did not help participants reduce the number of cigarettes they smoked during the follow-up moreso than participants' usual coping behavior (i.e., control group). The lack of effect on smoking behavior is consistent with the results of Rogojanski et al. (in press), but stands in contrast to Bowen and Marlatt (2009), who found that brief mindfulness-based instructions had no effect on cue-induced craving or affect in the laboratory but were associated with a greater decrease in smoking (26%) at 7-day follow-up compared to a control group (11%) (there was no suppression group). However, the current study differed from Bowen and Marlatt's study in several respects. First, during the laboratory session Bowen and Marlatt told their control group to cope

however they usually would, whereas our control group was not given any coping instructions. Therefore, they may have found no differences in craving or affect in the laboratory because their control group was also using coping strategies (perhaps suppression). Second, participants in the current study only tracked their smoking for 3 days, but the biggest drop in smoking occurred after day 3 in Bowen and Marlatt's study. Third, in the current study, all participants (including control group) were told to attempt to quit during follow-up, whereas it is unclear whether Bowen and Marlatt's participants were explicitly instructed to try to reduce their smoking. Our data reveal that our participants, including the control group, had knowledge of and used many strategies recommended in CBT, including chewing gum and other behavioral distractions. Finally, their participants were college students who smoked an average of 5 cigarettes per day and expressed an interest in cutting down or quitting, whereas our participants more closely resembled the general population of smokers (Hughes & Callas, 2010) and our criteria for interest in quitting were more stringent.

Limitations

The current study has limitations that must be acknowledged. First, although our participants planned to make a quit attempt within six months, they were not treatment-seeking. Future research should evaluate these strategies in treatment-seeking smokers, who would presumably be even more motivated to learn and use the strategies. Second, as mentioned previously, our coping instructions were quite brief and it is unclear whether the acceptance group achieved complete competence in applying acceptance. Future research may benefit from longer, more intensive instructions and more thorough

evaluation of participants' understanding and use of acceptance. Third, many of our measures were self-report, which are subject to demand effects.

Conclusion

The results of the current study lend additional legitimacy to acceptance as an alternative coping strategy, but do not support claims that acceptance is superior to suppression nor that reduction in smoking is mediated via use of acceptance, as neither acceptance nor suppression reduced smoking behavior to a greater degree than participants' usual coping behavior. More importantly, the current study addresses a primary criticism of the empirically-supported treatment (EST) movement—that it is focused on treatment *outcomes* (i.e., does a particular treatment "work" and for whom?) at the expense of basic research on treatment *processes* (i.e., how does it "work"?) (Doss, 2004; Morgenstern & McKay, 2007). Troublingly, existing process studies, including the current study, have demonstrated only limited support that ESTs "work" via their purported theoretical mechanisms (e.g., Burns & Spangler, 2001; Hayes et al., 2006). Furthermore, it has been somewhat difficult to demonstrate meaningful efficacy differences between different treatments, suggesting that common factors may underlie positive outcomes (e.g., Luborsky et al., 2002). The results of the current study support recent calls for a renewed commitment to basic research on therapeutic processes (e.g., Doss, 2004; Orford, 2008), with a goal of identifying "the active ingredients common to a small number of the most effective treatments" (Orford, 2008, p. 4).

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Appendices

Appendix A: Demographic Questionnaire

The following questions are about yourself and your life situation. They are to help us better understand the people we serve. You are under no obligation to answer any question that you find objectionable, however, we would appreciate your answering as many as possible. All answers will be kept confidential.

1. What is your age? _____

2. What is your date of birth?_____

3. What is your gender?
   - ❑ Male
   - ❑ Female

4. What is your marital status?
   - ❑ Single, never married
   - ❑ Living in marriage-like relationship
   - ❑ Married
   - ❑ Separated
   - ❑ Divorced
   - ❑ Widowed

5. With which racial category do you most identify yourself (check all that apply)?
   - ❑ American Indian/Alaska Native
   - ❑ Asian
   - ❑ Native Hawaiian or Other Pacific Islander
   - ❑ Black or African American
   - ❑ White

6. Are you Hispanic/Latino?
   - ❑ Yes
   - ❑ No

7. What is the highest grade level you have completed (please check <u>one</u>)?
   - ❑ Did not graduate high school
   - ❑ High school graduate
   - ❑ Some college
   - ❑ Technical school/Associates degree
   - ❑ 4-year college degree
   - ❑ Some school beyond 4-year college degree
   - ❑ Professional degree (e.g., MD, JD, PhD)

8. Your household income?
   - ❑ Under $10,000
   - ❑ $10,000 - $19,999
   - ❑ $20,000 - $29,999
   - ❑ $30,000 - $39,999
   - ❑ $40,000 - $49,999
   - ❑ $50,000 - $59,999
   - ❑ $60,000 - $69,999
   - ❑ $70,000 - $79,999
   - ❑ $80,000 - $89,999
   - ❑ $90,000 - $99,999
   - ❑ Over $100,000

Appendix B: Smoking Status Questionnaire (SSQ)

1. Do you smoke cigarettes every day? ❑ Yes ❑ No
   If No, stop here; If Yes, please continue

2. How many years have you been smoking daily?_____

3. How many cigarettes do you smoke per day on average (20 cigs=1 pack)?_____

4. Do you inhale? (circle one) NEVER SOMETIMES ALWAYS

5. Do you smoke more during the first two hours of the day than during the rest of the day?
   □ Yes □ No

6. How soon after you wake up do you smoke your first cigarette?
   □ Within 5 minutes
   □ 6-30 minutes
   □ 31-60 minutes
   □ After 60 minutes

7. Which of all the cigarettes you smoke would you most hate to give up?
   □ The first one in the morning
   □ The one with breakfast
   □ The one with lunch
   □ The one with dinner
   □ The last cigarette before going to bed
   □ Other:_____

8. Do you find it difficult to refrain from smoking in places where it is forbidden (eg. in church, at the library)
   □ Yes □ No

9. Do you smoke if you are so ill that you are in bed most of the day?
   □ Yes □ No

10. How old were you when you smoked your first cigarette? _____ years old

11. How old were you when you became a daily smoker? _____ years old

12. In your lifetime, how many times you have tried to quit smoking and gone at least 12 hours (i.e., 1 day) without smoking? _____ (# times)

13. In your lifetime, what is the longest period of time that you have quit smoking? (answer should be in days, months, or years) _____

14. In the past year, how many times you have tried to quit smoking and gone at least 12 hours (i.e., 1 day) without smoking? _____ (# times)

15. In the past year, what is the longest period of time that you have quit smoking (answer should be in days or months)? _____

16. Please indicate when your most recent quit attempt occurred. Please list the month and year when the attempt began and ended, and, if you remember, the exact days.

Date began: _____ Date ended: _____

Appendix C: Smoking-Related Cognitions (SRC)

Think about the most recent time when you quit smoking for at least 24 hours. Please place an up-and-down line ("|") on the scale to indicate how you felt during this time when you were NOT smoking:

1) How pleasant was the idea of having a cigarette?

NOT pleasant at all — EXTREMELY pleasant

2) How much did you try to suppress ideas about smoking (i.e., actively try not to think about smoking)?

NOT at all — EXTREMELY much

3) How strong was your urge to smoke?

NO urge — EXTREMELY strong urge

4) How able to resist the idea of smoking did you feel?

NOT able at all — EXTREMELY able

5) How strong was the urge to distract yourself from the idea of smoking in some way?

NOT strong at all — EXTREMELY strong

6) How in control of ideas about smoking did you feel?

NOT in control at all — EXTREMELY in control

7) How acceptable did you find the idea of smoking?

NOT acceptable at all — EXTREMELY acceptable

8) How uncomfortable did ideas about smoking make you?

NOT uncomfortable at all — EXTREMELY uncomfortable

9) How much did you think you would become relaxed if you had a cigarette?

NOT at all — EXTREMELY much

Appendix D: Quiz for Acceptance Group

Please answer the following questions <u>based on your understanding of the directions included in the presentation</u>. Please circle the letter that corresponds to the correct answer for each question.

1. When I start to have a craving for a cigarette, I should (circle one answer):

    a. Try not to think about cigarettes or smoking.
    b. Focus your attention on the craving.
    c. Acknowledge that you have no control over the craving.
    d. Strengthen your will power to resist the craving.

2. The Leaves on a Stream and Train examples can be helpful to (circle two answers):

    a. See your craving as separate from yourself.
    b. Notice your cravings in a way that makes them go away.
    c. Distract yourself from actually thinking about smoking.
    d. Help you to see a craving as no more than a craving.
    e. Show you that you can control your cravings and make them go away.

3. Defusion/distancing means (circle two answers):

    a. Removing oneself from the cause of the craving.
    b. Decreasing the craving.
    c. Stepping back from your thoughts.
    d. Reminding ourselves that we are not our thoughts.

Please answer the following additional questions (circle one answer per question):

4. How well did you understand the information in the presentation?
    a. Did not understand at all
    b. Understood a little bit
    c. Understood somewhat
    d. Understood well
    e. Understood very well

5. How interesting was the presentation?
    a. Not at all interesting
    b. A little bit interesting
    c. Somewhat interesting
    d. Very interesting
    e. Extremely interesting

6. How useful do you expect the instructions from the presentation will be for you during the upcoming task?
    a. Not at all useful
    b. A little bit useful
    c. Somewhat useful
    d. Very useful
    e. Extremely useful

Appendix E: Quiz for Suppression Group

Please answer the following questions based on your understanding of the directions included in the presentation. Please circle the letter that corresponds to the correct answer for each question.

1. When I start to have a craving for a cigarette, I should (circle two answers):

    a. Try not to think about cigarettes or smoking.
    b. Focus your attention on the craving.
    c. Acknowledge that you have no control over the craving.
    d. Strengthen your will power to resist the craving.

2. What is biofeedback? (circle one answer)

    a. A treatment method that teaches people how to increase their awareness of physical changes, and to exercise control over their own physical reactions.
    b. A treatment method that teaches people how to increase their awareness of their thoughts.
    c. A treatment method that teaches people how to quit smoking.

3. According to the presentation, when I feel craving unexpectedly, I should (circle one answer):

    a. Accept it, and focus my attention on my behavior.
    b. Stay in control of my craving at all times, by pushing the craving feeling away.
    c. Get out of the situation immediately.
    d. Try to determine the cause of my craving.
    e. Try to distract myself from feeling craving by focusing on other things.

Please answer the following additional questions (circle one answer per question):

4. How well did you understand the information in the presentation?
    a. Did not understand at all
    b. Understood a little bit
    c. Understood somewhat
    d. Understood well
    e. Understood very well

5. How interesting was the presentation?
    a. Not at all interesting
    b. A little bit interesting
    c. Somewhat interesting
    d. Very interesting
    e. Extremely interesting

6. How useful do you expect the instructions from the presentation will be for you during the upcoming task?
    a. Not at all useful
    b. A little bit useful
    c. Somewhat useful
    d. Very useful
    e. Extremely useful

Appendix F: Quiz for Control Group

Please answer the following questions based on your understanding of the information included in the presentation. Please circle the letter that corresponds to the correct answer for each question.

1. What is a symbiotic relationship?

    a. Two animals of the same species who work together to help each other survive.
    b. Two animals of the same species who are in competition with each other.
    c. A partnership between two animals of different species that helps at least one of the animals to survive.
    d. Two people who work together.

2. How does the cleaner shrimp help fish at coral reefs?

    a. The cleaner shrimp finds food and gives it to the fish.
    b. The cleaner shrimp removes stuff from the fish's body that can hurt the fish.
    c. The fish eat cleaner shrimp.
    d. The cleaner shrimp cleans the coral reef so the fish can live in it.

3. How do the honeyguide bird and the ratel help each other?

    a. The honeyguide bird finds beehives and the ratel uses its sharp claws to open the hives.
    b. The ratel finds beehives and the honeyguide bird uses its beak to open the hives.
    c. The honeyguide bird makes honey for the ratel to eat.
    d. The ratel makes honey for the honeyguide bird to eat.

4. How does the clownfish help the sea anemone?

    a. The clownfish removes bugs and other pests from the anemone.
    b. The clownfish puts a layer of mucus on the anemone to protect it.
    c. The sea anemone eats clownfish.
    d. The clownfish chases away predator fish and attracts fish food toward the anemone.

Please answer the following additional questions:

5. How well did you understand the information in the presentation?
    a. Did not understand at all
    b. Understood a little bit
    c. Understood somewhat
    d. Understood well
    e. Understood very well

6. How interesting was the presentation?
    a. Not at all interesting
    b. A little bit interesting
    c. Somewhat interesting
    d. Very interesting
    e. Extremely interesting

Appendix G: Manipulation Check

Using the scale below, please indicate how much you used each of the strategies during the tasks you just completed (holding the lit cigarette and viewing the pictures, and recording your thoughts afterward). Please do not take into account how much you were asked to use each strategy, rather, record how much you actually did the following during the tasks. Circle your answers. *(Note: last sentence was omitted for the control group).*

0-----1-----**2**-----3-----**4**-----5-----**6**-----7-----**8**

Never	Some of the time	Frequently	Most of the time	All of the time

During these tasks (holding lit cigarette and viewing pictures, recording thoughts after), how much did you:

1. Tell yourself to not feel craving or think about smoking.
0-----1-----**2**-----3-----**4**-----5-----**6**-----7-----**8**

2. Observe your craving from a distance without trying to change it or make it go away.
0-----1-----**2**-----3-----**4**-----5-----**6**-----7-----**8**

3. Do something to actively change how you were feeling.
0-----1-----**2**-----3-----**4**-----5-----**6**-----7-----**8**

4. Allow yourself to experience whatever smoking-related thoughts and craving came up for you.
0-----1-----**2**-----3-----**4**-----5-----**6**-----7-----**8**

5. Try to control and get rid of your smoking-related thoughts and craving.
0-----1-----**2**-----3-----**4**-----5-----**6**-----7-----**8**

6. Maintain awareness of your thoughts and cravings at each moment.
0-----1-----**2**-----3-----**4**-----5-----**6**-----7-----**8**

(only for suppression and acceptance groups)

7. How useful were the instructions from the presentation for you during the task (circle one)?

1. Not at all useful
2. A little bit useful
3. Somewhat useful
4. Very useful
5. Extremely useful

(only for control group)

7. Please describe below how you responded to craving during the task:

Appendix H: Questionnaire of Smoking Urges-4 (QSU-4), One-Item Urge (1-Urge), and Magnitude Estimation of Urge (ME)

QSU-4

Indicate how much you agree or disagree with each of the following statements by marking one of the circles between STRONGLY DISAGREE and STRONGLY AGREE. You do not have to fill in the circle, just make a check mark or X over the circle of your choice. The closer you place your mark to one end or the other indicates the strength of your agreement or disagreement. We are interested in how you are thinking and feeling ***right now*** as you are filling out the questionnaire.

1. I have a desire for a cigarette right now.

STRONGLY DISAGREE	O	O	O	O	O	O	O	STRONGLY AGREE

2. I am going to smoke as soon as possible.

STRONGLY DISAGREE	O	O	O	O	O	O	O	STRONGLY AGREE

3. I do want to smoke now.

STRONGLY DISAGREE	O	O	O	O	O	O	O	STRONGLY AGREE

4. I will smoke as soon as I get the chance.

STRONGLY DISAGREE	O	O	O	O	O	O	O	STRONGLY AGREE

One-Item Urge

On a scale from 0 to 100, with 0 being no craving at all and 100 being the most craving you can imagine, what is your craving for a cigarette **right now**? Write a number between 0 and 100.

_____

ME

Now I want you to compare your **current** urge to smoke to how you felt when you first arrived here today (**initial** urge). Assign your initial urge a value of 10. For example, if your current urge is double your initial urge, you would rate your current urge as 20. Another example is if your current urge is half of your initial urge, you would rate your current urge as 5.

Initial urge when arrived: 10 Current urge: _____

Appendix I: Mood Form (Trait)

Please indicate how much you have experienced each of the following moods **during the past three weeks** by placing a checkmark on EACH line.

	Not at all	Very slight	Some what	Moderate amount	Much	Very much	Extremely much
Happy	_____	_____	_____	_____	_____	_____	_____
Depressed/Blue	_____	_____	_____	_____	_____	_____	_____
Joyful	_____	_____	_____	_____	_____	_____	_____
Unhappy	_____	_____	_____	_____	_____	_____	_____
Pleased	_____	_____	_____	_____	_____	_____	_____
Enjoyment/Fun	_____	_____	_____	_____	_____	_____	_____
Frustrated	_____	_____	_____	_____	_____	_____	_____
Worried/Anxious	_____	_____	_____	_____	_____	_____	_____
Angry/Hostile	_____	_____	_____	_____	_____	_____	_____

Appendix J: One-Item Discomfort (1-Discomfort) and Mood Form (State)

One-Item Discomfort

At this moment, indicate your level of discomfort with thoughts about smoking and craving on a scale from 0 "NOT uncomfortable at all" to 100 "EXTREMELY uncomfortable." Write a number between 0 and 100.

_____

Mood Form (State)

Now please indicate how much you are experiencing each of the following moods ***right now*** by placing one checkmark on EACH line.

	Not at all	Very slight	Some what	Moderate amount	Much	Very much	Extremely much
Happy							
Depressed/Blue							
Joyful							
Unhappy							
Pleased							
Enjoyment/Fun							
Frustrated							
Worried/Anxious							
Angry/Hostile							

Appendix K: Cigarette Tracking Sheets

Cigarettes
Day 1

Participant #:_____ Date:____

Date of Week (circle)
M T W R F Sa Su

Time	Cigarettes
1st cig:	
9 a.m. - Noon	
12 - 3 p.m.	
3 – 6 p.m.	
6 – 9 p.m.	
9 p.m. - Mid	

Cigarettes
Day 2

Participant #:____ Date:_____

Date of Week (circle)
M T W R F Sa Su

Time	Cigarettes
Mid- 3 a.m.	
3 – 6 a.m.	
6 – 9 a.m.	
9 a.m. - Noon	
12 - 3 p.m.	
3 – 6 p.m.	
6 – 9 p.m.	
9 p.m. - Mid	

Cigarettes
Day 3

Participant #:_____ Date:____

Date of Week (circle)
M T W R F Sa Su

Time	Cigarettes
Mid- 3 a.m.	
3 – 6 a.m.	
6 – 9 a.m.	
9 a.m. - Noon	
12 - 3 p.m.	
3 – 6 p.m.	
6 – 9 p.m.	
9 p.m. - Mid	

Appendix L: One-Item Self-Efficacy (1-SE) and Smoking: Self-Efficacy/Temptation (SET)

One-Item Self-Efficacy

How confident are you that you could go for one year without smoking, if you would try to quit smoking now, on scale from 0 "NOT at all confident" to 100 "EXTREMELY confident"? Write a number between 0 and 100.

_____

Smoking: Self-Efficacy/Temptation

Instructions: Listed below are situations that lead some people to smoke. We would like to know HOW CONFIDENT you are that you could avoid smoking in each situation. Please answer the following questions using the following five-point scale.

		Not at all confident	**Not very confident**	**Moderately confident**	**Very confident**	**Extremely confident**
1	At a bar or cocktail lounge having a drink.	1	2	3	4	5
2	When I am desiring a cigarette.	1	2	3	4	5
3	When things are not going the way I want and I am frustrated.	1	2	3	4	5
4	With my spouse or close friend who is smoking.	1	2	3	4	5
5	When there are arguments or conflicts with my family.					
6	When I am happy and celebrating.	1	2	3	4	5
7	When I am very angry about something or someone.	1	2	3	4	5
8	When I would experience an emotional crisis, such as an accident or death in the family.	1	2	3	4	5
9	When I see someone smoking and enjoying it.	1	2	3	4	5
10	Over coffee while talking and relaxing.	1	2	3	4	5
11	When I realize that quitting smoking is an extremely difficult task for me.	1	2	3	4	5
12	When I am craving a cigarette.	1	2	3	4	5
13	When I first get up in the morning.	1	2	3	4	5
14	When I feel I need a lift.	1	2	3	4	5
15	When I begin to let down on my concern about my health and am less physically active.	1	2	3	4	5

Appendix L (Continued)

16	With friends at a party.	1	2	3	4	5
17	When I wake up in the morning and face a tough day.	1	2	3	4	5
18	When I am extremely depressed.	1	2	3	4	5
19	When I am extremely anxious and stressed.	1	2	3	4	5
20	When I realize I haven't smoked for a while.	1	2	3	4	5

Appendix M: Intervention Script for Suppression Condition

I am going to spend some time now discussing a way that you can approach the coming task, and your craving for cigarettes in general. I would like for you to listen as I describe this to you, and consider whether this fits with your experience.

What I would like to suggest to you is that when you really put your mind to it, you can control most things in your life, including your craving for cigarettes after you quit smoking.

Think about how much control you have over yourself everyday. Have you ever woken up in the morning, and not really felt like getting out of bed? You might've had a struggle with yourself, bargaining for just a few extra minutes, but eventually, you talk yourself into getting into the shower, because you know you have somewhere to be. Even though you don't feel like it, you do it, because you know it's important. You exercise control over your behavior every day. It's all about mind over matter. And it is the same way with controlling your craving after you quit smoking. Without thinking about it, you probably exercise control over your mind and your behavior throughout most of your life.

And it makes sense that you do. If you didn't, your thoughts and feelings would be all over the place. Think about some of the most popular phrases that parents use with their kids, "don't cry, it's okay…don't be scared…be brave…" On some level we have all learned, and we all believe, that it is important for us to be in control of our mind at all times. When we have scary thoughts, we tell ourselves to be brave, when we feel sad about things, we call a friend to help cheer us up, when we are angry with our bosses at work, we try to stifle our anger so that we don't explode, and when we worry about things, we do whatever we can to reassure ourselves that everything is really okay. This is an important part of survival. Think about what would happen if you just let your craving for cigarettes rule your life! You can't always indulge in craving and let the craving make decisions for you, such as deciding to end your quit attempt and smoke a cigarette. Instead, you have to control urges and cravings to smoke, so that you can successfully quit smoking, and remain smoke-free for the rest of your life.

Have you ever had a personal problem, and made a big effort to not let it affect your performance in work or school? Even though you feel really upset inside, you can somehow manage to push it away long enough to perform well. Well, it's the same thing with controlling craving after you quit smoking. When you are feeling urges and cravings, but you really don't want to smoke a cigarette because you have decided that you want to quit smoking, you can push the craving away in order to accomplish your goal of being smoke-free. That's what I am going to encourage you to do today. Try not to feel craving, try not to even think about craving or smoking, try to just get through the task with as little craving and smoking-related thoughts as possible. If an image pops into your mind related to smoking, immediately get rid of it and stop thinking about it. That's the goal.

Think about the people you might see on TV walking over hot coals or lying on a bed of nails. It's not that the coals don't feel hot, or that the nails aren't sharp, it's that these people have a lot of control over their emotional reactions, and are able to tolerate the pain, because they tell themselves not to feel it. By willfully trying to reduce the pain, these people can successfully endure experiences that other people cannot tolerate. It's all about the control here, if they let their emotions run wild, they would never be able to complete the task. Instead, they exercise a great degree of control over their feelings and behaviors, and they are able to do it! The same thing applies to you and your craving for cigarettes. If you try very hard to willfully reduce your craving and your desire to smoke, you will have an easier time with it. Don't let your craving control you, you control your craving.

If you are thinking to yourself right now that this all sounds much easier than it actually is, you are probably right. After all, you are here today because you've tried to quit smoking in the past but you were not successful. It may be your instinct to try and make your craving go away when it comes up, but it is by no means an easy thing to do. It takes a lot of concentration and effort. I would like to suggest to you though, that this really is a successful strategy, and that it is really important that you master it. If it is difficult for you to do, perhaps you need to try a little harder. I am not suggesting any particular way for you to reduce your craving, but just suggesting that if you try hard enough to get rid of craving, you will likely succeed.

The thing is, it is a normal part of the experience of quitting smoking to feel uncomfortable urges and cravings to smoke. Where this process goes awry, is when we let them get in our way, by letting craving get out of control. Instead of letting your craving be the master of you, you need to be the master of craving. It's like I said before, mind over matter.

I'd like to give you one final example of how we really can control our own thoughts and feelings. Have you ever heard of biofeedback? Well, biofeedback is a treatment method that teaches people how to increase their awareness of physical changes, and to exercise control over their own physical reactions. This treatment uses monitoring instruments to "feed back" information about bodily processes of which we are normally unaware. By watching the monitoring device during biofeedback, people can learn to adjust their thinking and other mental processes in order to control bodily functions that most people think of as involuntary, like blood pressure and heart rate. Basically, biofeedback is a training technique that teaches people to improve their own health and performance by exercising control over their body through the use of their minds. Research on this technique suggests that there is a very strong connection between our minds and our bodies, and that we can actually use mental control to modify our physiological responses (like heart rate). What this tells us, is that if you try very hard to control your craving, it is likely that you will be able to, because increased mental control likely leads to increased physical control (like control over uncomfortable physical sensations) and

behavioral control (like control over whether you actually pick up that cigarette and smoke it). So, what we can learn from biofeedback, and apply to the upcoming task, is that if you try very hard to reduce your feelings of craving and desire to smoke, it is likely that you will be able to change them, and your behavior as well. It is likely that you won't decide to just smoke the cigarette.

I am not suggesting that if you use these strategies for dealing with craving when you quit smoking that you will never experience any craving, but that, rather than just giving into the craving, and accepting it, if you actively try to get it out of your mind and make it go away, you will experience less craving in the end, and you will be more likely to be successful at quitting smoking. If you make an effort to really battle the craving that comes up for you, and win the fight against these feelings, you can begin to focus on what really matters in your life. Once you get rid of the craving, you will be able to control whether you smoke, instead of letting your craving make that choice for you. As I said before, think mind over matter…you can master these feelings and make them go away.

In a few minutes we are going to begin the task I mentioned earlier. When you quit smoking, you will often be exposed to cues and situations that remind you of smoking and make you crave a cigarette. In this exercise we are going to expose you to some of these cues and situations. I want you to think of this task as practice for your upcoming quit attempt. In real life, many people relapse when exposed to these cues and situations, because they give in to their craving and let it get the best of them. Eventually they decide they can't stand the craving any more, their quit attempt has failed, and they begin smoking again. During this exercise I would like you to actively try to control your craving. If thoughts or images about smoking pop into your head, immediately push them away and get them out of your mind. Just don't think about craving or smoking! Remember, the harder you try not think about smoking and not feel craving, the less craving you will feel, and the better you will do in your upcoming quit attempt.

Appendix N: Intervention Script for Acceptance Condition

I am going to spend some time now discussing a way that you can approach the coming task, and your craving for cigarettes in general. I would like you to listen as I describe this to you, and consider whether this fits with your experience.

What I would like to suggest to you is that the very thing that many people who are trying to quit smoking do when they are craving a cigarette, try to control it or get rid of it, actually makes craving worse.

Frequently people who are quitting smoking wish to avoid craving. If there is any way to turn the craving off, or lessen it (such as by avoiding situations, avoiding thinking about smoking, or distracting themselves), they will usually try to do this. On one level this makes sense…of course people don't like to experience craving for cigarettes, it's uncomfortable and makes them worried that they will fail at quitting smoking, so why wouldn't they want to turn it off or get rid of it?

We are taught from a young age that we can control our mind, including cravings. However, psychologists have begun to realize that direct attempts to control our internal experience (things like thoughts and feelings), don't usually work for very long, if they work at all. We can tell ourselves to "stop thinking about this," but psychologists have realized that trying to control craving is most likely not going to be successful.

Let me give you an example. Try this: for the next 30 seconds do not let your mind think about or imagine a blue truck. Don't think about what it looks like and don't think about driving one.

Suppose I offered a 1 million dollar reward to anyone who could do this, and I wired you up to a mind-reading machine to verify if you could or not could not complete the task. What do you think would happen? So this example shows that we cannot control our thoughts even when we have the most intense motivation to do so. It works the same for cravings: In the same way that we can't control what we think about, we can't control how we feel or our cravings. If you're trying to quit smoking and you have cravings to smoke a cigarette, then you have them and there's not much you can do about having them.

The thing is, it is a normal part of the experience of quitting smoking to have thoughts about smoking and cravings to smoke. Where this process goes awry, is when we get in our own way, by forcefully trying to make craving go away. Even worse, sometimes our confidence in our ability to stay smoke-free becomes dependent on our ability to control urges and cravings, and then when we find that we can't, we end up feeling worse and worse. You see, it is really your effort to push your craving away that is the enemy, it's not the craving itself.

If we don't try to control or suppress our cravings what can we do? Perhaps it could help us to accept that we are going to have cigarette cravings no matter what and we can't do anything to stop our mind from wanting something that feels good.

If we can't accept what it feels like to have a craving, where does that leave us? What must we do if we don't have a control to turn down a craving, but we can't stand what it feels like to have the craving? … That's right. We have to give in to the craving and smoke! Is there another option? … Yes, we could figure out a way to tolerate the craving feeling. The ability to tolerate a feeling or thought is called *Willingness.* Although we don't have much control over what we feel or think is it possible that we *do* have control of our willingness to feel and think certain things? Can you imagine saying to yourself: No matter how strong this craving to smoke gets, I'm just going to let it be in my head. I don't need to make it go away?

Psychologists have discovered that it is incredibly useful to be able to notice and observe your own internal experiences. What do I mean by internal experiences? They are things like your thoughts: "She doesn't like me." "That was stupid." "I really messed up at work." Another type of internal experience is feelings, including emotions like sadness, anxiety and excitement. Cravings and urges to do things (like smoke cigarettes) are internal experiences. So are physical feelings like having an itch and sensations like smells and sounds. Try to just sit back and notice whatever internal experiences you are having right at this second. What do you see, hear, smell, and feel? What are you thinking? Was that possible?

Sometimes it is easier get this concept using a metaphor. A metaphor is when something else is used to represent a concept, in order to see a similarity and make the concept easier to understand. For example, imagine a stream with lots of leaves floating in it. The leaves are moving down the stream, some slowly, and some fast. Now think of the stream as your mind, and each leaf as a different internal experience that is going by. So one leaf is the thought that you forgot to call your friend back, another is a feeling of being very hot, etc.

Here's a similar metaphor example. Imagine that you are standing at a railway bridge gazing down at a long freight train rumbling along that has many, many train cars that stretch far into the distance. The cars are open-topped, so you can see the freight inside each one. The freight is labeled and is, in fact, the content of your mind: some of the cars have your thoughts, some have your emotions and cravings, and some have the noises, sights and sounds you are sensing. So one car might have the "smell of perfume," another might have the thought "I am never going to get this work done," one might have the feeling of hopelessness and one might have a craving to smoke a cigarette.

A very important way to increase willingness and decrease the distress you have about cravings is to distance yourself from the craving. When we distance from a craving we

'step back from' ourselves and our cravings and see ourselves having the cravings from a psychological distance. When we are distanced we can experience cravings (or any thought or feeling) as just a feeling our mind is having at that moment. Maybe we can even realize this craving feeling is nothing more than chemical and electrical activity in our brain. When we have this kind of distance from our thoughts and feelings we can choose not to do what those thoughts and feelings are 'telling' us to do. In other words, we can say: 'I can see myself having a craving to smoke a cigarette right now. It's a really strong craving. But I'm going to let that feeling just be and choose not to smoke.

Conjure up the image of looking down at the train from the bridge. In your mind's eye can you get perspective so that you can see each thought or feeling or craving you have *from a distance?* Now can you imagine being *inside* a particular car where the only thing in your field of vision is a huge sign that says "Craving to smoke!" That difference between being inside the train car and seeing the train car from a distance is what we mean by distancing.

Take a minute to notice each thought and feeling and craving that you are experiencing right now. But this time, try to step back, *see* yourself having the experience, and describe it to yourself. So say things to yourself like "Now I'm seeing that my mind is having the thought that I didn't do a very good job on that paper." And "Now see that I really have a craving for some gum." What was that like? Were you able to achieve distance?

In a few minutes we are going to begin the task I mentioned earlier. When you quit smoking, you will often be exposed to cues and situations that remind you of smoking and make you crave a cigarette. In this exercise we are going to expose you to some of these cues and situations. I want you to think of this task as practice for your upcoming quit attempt. In real life, many people relapse when exposed to these cues and situations, because they try to control the craving, but it just gets worse and worse. Eventually they decide that because they cannot control their craving, their quit attempt has failed, and they begin smoking again. During this exercise, I would like you to become aware of what it is that you are thinking and feeling and craving in any given moment. Accept them, and step back from them by seeing them from a distance, and imagine seeing yourself having a craving. Whatever thoughts or feelings or cravings your mind creates are OKAY. Be willing to have whatever your mind gives you. Now matter how strong a craving is, you can let it be. You don't have to make it go away. Remember, the harder you try to, "not feel craving," the more craving and thoughts about smoking you will have.

Appendix O: Intervention Script for Control Condition

As I mentioned earlier, we are also interested in the effects of nicotine on cognitive abilities like reading comprehension and memory. During this presentation, you will learn about some unique animals that pair up with other animals to help them survive in the wild. This presentation is based on an article that appeared in a magazine called *National Geographic Explorer!* (Original article obtained from http://magma.nationalgeographic.com/ngexplorer/0601/articles/mainarticle.html).

PAIRING UP FOR SUCCESS

Living in the wild can be hard. Finding food and staying safe aren't easy. Each day, animals struggle to survive in their own habitats.

Not all animals get by on their own. Some animals form a close partnership with other kinds of animals. These pairings are called symbiotic relationships. In a symbiotic relationship, the animals depend on each other. One animal helps the other meet its needs.

Symbiotic relationships sound good, right? Not always. Some animals are not very kind to their partners. In some cases, one animal meets its needs but hurts its partner. It sounds crazy, but it does happen. Take ticks, for example. These insects guzzle blood to live. To get blood, they attach themselves to other kinds of animals. Ticks do not help their hosts. Instead, they can pass germs that cause disease.

In other relationships, animals don't treat their partners so poorly. Both animals benefit, or get help, from living with the other animal. Let’s check out how some animals pair up to survive.

KEEPING CLEAN

One example is a small animal called the cleaner shrimp. Cleaner shrimps have found a way of helping fish at coral reefs. As their name suggests, the shrimps clean the fish. Here's how it works.

The shrimps hang out at what scientists call a cleaning station. A fish stops by and the shrimp climbs onto the fish. The shrimp even steps into the fish's mouth.

The shrimp uses its tiny claws to pick stuff off the fish's body. That can include dead skin, tiny pieces of food, and small creatures that can actually hurt the fish. The fish gets a nice cleaning, and the shrimp enjoys a tasty meal of fish trash.

Small birds called plovers are also in the cleaning business. They have big customers—crocodiles. Crocodiles have long snouts filled with sharp teeth and cleaning them is tricky. That's where the plover comes in. When a croc opens its mouth, the plover hops right in. The croc does not snap its snout shut. Instead, it lets the plover eat small,

harmful animals attached to the crocodile's teeth. The plover gets an easy meal and the croc gets clean teeth.

EASY RIDERS

Many animals have to chase after a meal. Not the oxpecker. Instead of swooping through the sky searching for insects, this bird catches a ride aboard large animals from antelope to zebras.

Don't those animals mind carrying birds on their backs? No. You see, an oxpecker picks ticks and other pests off its buddy's body. That helps the animal stay free of blood-sucking bugs. In exchange, the oxpecker gets plenty of food. It's a perfect partnership.

Egrets also hang out with large animals, such as hippos and rhinos. When those big beasts walk, their feet stir up insects and other small animals on the ground. That means the egret doesn't have to look far for a meal.

SWEET SUCCESS

Some animals need each other because they like the same food. Take the honeyguide bird and the ratel. They live on grasslands in Africa.

Both animals love honey. Yet each has a problem getting some. The bird can find a beehive, but can't open it. The ratel can open a hive, but doesn't know how to find one.

So the two animals team up. The bird flies over the grasslands, looking for hives. When it spots one, it swoops down and makes noise. The sound tells the ratel to come and eat.

The ratel uses its sharp claws to tear apart the hive. It gobbles up most of the honey-covered mess. Then the honeyguide bird enjoys finishing off the leftovers.

CLOWNING AROUND

Land and sky animals aren't the only ones that work together. So do some sea animals. One of the oddest couples is made up of the sea anemone and the clownfish.

You might think sea anemones look like plants, but they are really hungry animals. They attach themselves to a rock or a coral reef and there they wait for a fish to swim by. Then they sting it with their tentacles. The stunned fish is then pulled into a sea anemone's hidden mouth.

Still, one daring fish makes its home among sea anemones. It's the clownfish. This orange-and-white fish isn't kidding around. Its body is shielded by a thick layer of mucus. The slime protects the clownfish from the sea anemone's dangerous, stinging tentacles.

The clownfish is also a good neighbor. It helps the sea anemone by luring in the fish. When a hungry fish spots a colorful clownfish, it darts toward it. The clownfish safely swims under the anemone's tentacles. If the hungry fish follows, it gets stung. Then it becomes the anemone's next meal.

The brave clownfish not only reels in fish food, it chases away fish that might eat an anemone. So the clownfish and anemone help keep each other fed and safe.

A DIFFERENT WAY OF LIFE

All animals want to do one thing—survive in the wild. Some do that by living alone. Others live in flocks, herds, hives, packs, or schools. Some animals, both large and small, know the best way to stay alive is to live with or near other kinds of animals.

At first glance, these teammates don't seem to make sense. If you look more closely, you'll soon learn that these animals help one another find food, shelter, and safety. They make the most of their various differences. These unlikely partners pair up to get the most out of life.

About the Author

Erika B. Litvin grew up in southeastern Massachusetts and earned a B.A. in Psychology and Public Policy from Brown University in 2003. She will receive her Ph.D. in Clinical Psychology in 2011 from the University of South Florida, where she studied under the mentorship of Thomas H. Brandon, Ph.D. Erika completed her clinical psychology internship training at the Alpert Medical School of Brown University in 2011. She is continuing her training as a postdoctoral fellow at Brown from 2011-2013. Erika is an author on several peer-reviewed articles and conference presentations in the areas of tobacco use, cessation, and relapse.