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I, Christina Marie Luberto, hereby submit this original work as part of the requirements for the degree of Doctor of Philosophy in Psychology.

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An Experimental Test of the Effects of A Brief Mindfulness Exercise on Distress Tolerance Among Adult Cigarette Smokers

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An Experimental Test of the Effects of A Brief Mindfulness Exercise on Distress Tolerance Among Adult Cigarette Smokers

A Dissertation Project

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Abstract

The inability to tolerate negative emotional states is associated with poor smoking outcomes (Brown et al., 2002; Brown et al., 2009). Mindfulness training is one technique used to increase distress tolerance, and preliminary research suggests improvements in distress tolerance might be one mechanism by which mindfulness training increases the chances of successfully quitting smoking (Abrantes et al., 2008; Bowen & Marlatt, 2009). However, no research, to date, has examined whether mindfulness training actually increases distress tolerance in smokers. Thus, the purpose of the current study was to examine the effects of a brief mindfulness exercise on smokers’ perceived and behavioral distress tolerance, smoking urges in response to emotional distress, state mindfulness, and distress levels. Participants were 91 regular daily smokers ($M_{age} = 46.03$, $SD = 9.97$; 55% male, 74% African-American) who completed behavioral distress tolerance tasks and self-report measures of distress tolerance, distress levels, smoking urges, and state mindfulness before and after a brief mindfulness or control exercise. As hypothesized, results indicated that the brief mindfulness training significantly increased state mindfulness and showed a trend toward decreased distress levels. Contrary to prediction, the mindfulness training was not associated with improvements in distress tolerance or reductions in smoking urges over time. The current findings suggest that brief mindfulness exercises might provide several benefits for smokers, but they should not be expected to produce immediate improvements in distress tolerance or smoking urges in smokers.
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Introduction

Cigarette Smoking

Following the release of the Surgeon General’s report publicizing the negative health consequences of cigarette smoking in 1965, smoking prevalence rates dropped substantially from 42% in 1965 to 25% in 1990 (Center for Disease Control and Prevention [CDC], 2009; 2012). However, despite increased efforts to reduce smoking prevalence, the smoking rate has not declined as anticipated over the past 20 years (Pleis, Lucas, & Ward, 2009). One possible explanation for this lack of success, the “hardening” hypothesis, posits that smokers who could easily quit have already done so, and the remaining population of smokers now consists primarily of individuals burdened with certain characteristics (e.g., psychiatric comorbidities, greater nicotine dependence) that are associated with greater difficulties in quitting smoking (Hughes, 2011; Warner & Burns, 2003). Thus, it is critical to identify effective ways to help smokers with these characteristics successfully quit smoking.

Currently, approximately 18% of adults in the U.S. are current cigarette smokers, with higher prevalence rates among males (20.5%) compared to females (15.8%), and American Indians/Alaska Natives (21.8%) compared to Caucasians (19.7%), African Americans (18.1%), and Asians (10.7%; CDC, 2014). Smoking is also more common among non-Hispanics (27.4%) than Hispanics (12.9%), individuals from low socioeconomic backgrounds (28%), those with less education (42%), and among those with mental illness (41%; CDC, 2014; Goodwin, Zvolensky, & Keyes, 2008; Lasser et al., 2000). The onset of daily smoking typically occurs between the ages of 15 and 20 and rarely after age 25 (Breslau, Johnson, Hiripi, Kessler, 2001; Substance Abuse and Mental Health Services Administration [SAMHSA], 2010). The average adult smoker in the U.S. smokes approximately 13 cigarettes per day, with males smoking, on average, more cigarettes per day than females (14 cigarettes and 12 cigarettes, respectively; SAMHSA, 2003).
Smoking remains the leading preventable cause of death and disability in the U.S., accounting for over 440,000, or 1 in 5, deaths each year (U.S. Department of Health and Human Services [USDHHS], 2004). Smoking harms nearly every organ of the body, resulting in approximately 8.6 million individuals in the U.S. who suffer from one or more serious illnesses associated with cigarette smoking, including several different types of non-lung-related cancers (e.g., kidney, bladder, cervical), respiratory disease (e.g., emphysema, bronchitis), cardiovascular disease, and reproductive problems (e.g., infertility, stillbirth; USDHHS, 2004). Compared to non-smokers, smokers have (1) higher rates and longer periods of absenteeism from work; (2) more frequent physician visits; (3) more frequent and longer hospitalizations; (4) more frequent emergency room visits; and (4) greater prescription drug usage (USDHHS, 2004). Recent reports estimate that the total costs of cigarette smoking are approximately $193 billion per year or $10.47 per pack of cigarettes sold in the U.S. (CDC, 2008).

Given these negative health effects, many smokers are motivated to quit smoking. Nearly 70% of smokers report a desire to quit smoking in any given year, and of those, approximately half make a quit attempt (CDC, 2011). However, most smokers who do attempt to quit smoking are not successful and quickly relapse (West, McEwen, Bolling, & Owen, 2001). Approximately 77% of adults in smoking cessation programs relapse within the first month, and 95-97% of those who attempt to quit smoking without treatment relapse within 6-12 months (Bränström, Penilla, Perez-Stable, & Munoz, 2010; Hughes, Keely, & Naud, 2004). It is estimated that smokers make, on average, 8 to 11 quit attempts before they are successful (USDHHS, 2001). One of the reasons that smoking cessation is so difficult is due to the pharmacological effects of nicotine, which has been found to be as addictive as heroin, cocaine, and alcohol (USDHHS, 2010). Further, experiencing aversive nicotine withdrawal symptoms during a quit attempt often results in an individual returning to smoking (Fiore et al., 2008).

**Negative Affect and Smoking**
One of the most common symptoms of nicotine withdrawal is negative affect (Hughes, Higgins, & Hatsukami, 1990). In general, smokers report greater levels of negative affect than non-smokers (Kassel, Stroud, & Paronis, 2003). Smokers also consistently report (1) a belief that smoking helps them cope with emotional distress; (2) negative affect reduction is a primary motivation for smoking; and (3) negative affect is a strong smoking trigger (Brandon & Baker, 1991; Copeland, Brandon, & Quinn, 1995; Piper et al., 2004). Indeed, negative affect is associated with stronger smoking urges, particularly during periods of smoking deprivation (Leventhal et al., 2013).

Negative affect is considered one of the most powerful predictors of cessation success or failure (Kenford et al., 2002). Smokers who tend to smoke when experiencing negative affect are at an increased risk of lapse and relapse during a quit attempt (Shiffman et al., 2007), and increases in negative affect following a quit attempt account for over 60% of all smoking lapses (Shiffman, Paty, Gnys, Kassel, & Hickcox, 1996). Theoretically, the increased negative affect associated with nicotine withdrawal motivates smokers to return to smoking in order to reduce, avoid, or escape the negative emotions that occur during a cessation attempt (Abrantes et al., 2008; Baker, Piper, McCarthy, Majeskie, & Fiore, 2004; Piasecki et al., 2000; Shiffman et al., 1996). In fact, recent research suggests that a smoker’s ability to tolerate and regulate negative affect plays a critical role in cessation success (Abrantes et al., 2008; Brown, Lejuez, Kahler, Strong, Zvolensky, 2005; Brown et al., 2008). Thus, better understanding smokers’ ability to experience and withstand negative affect, as well as the factors that enhance this ability, are important next steps in smoking cessation research.

Distress Tolerance

Distress tolerance, defined as the ability to withstand aversive emotional states (Simons & Gaher, 2005), has been identified as an important factor in negative affect regulation. Although distress tolerance has been the focus of clinical and research attention for over a century, it has garnered increasing attention over the past two decades. This surge of interest in
distress tolerance began with Linehan’s seminal work on borderline personality disorder. Specifically, Linehan (1993) proposed that a defining characteristic of borderline personality disorder is an inability or unwillingness to tolerate negative emotions coupled with an inability to regulate negative emotions.

More recent conceptualizations posit that distress tolerance reflects an individual’s evaluations of, and expectations about, (1) the level of aversiveness and tolerability of an emotion; (2) the acceptability of an emotion; (3) the need for emotion regulation strategies intended to avoid or reduce an emotion; and (4) how much an emotion absorbs attentional resources and disrupts behavior (Simons & Gaher, 2005). Thus, distress tolerance is thought to influence which emotion regulation strategies an individual uses in a given situation, with individuals with low levels of distress tolerance typically employing emotion regulation strategies that are maladaptive or ineffective in the long term (Simons & Gaher, 2005; Linehan, 1993). For example, a socially anxious male with low distress tolerance who attends a large party will likely have anxiety symptoms that are experienced as aversive, intense, and overwhelming and consume all of his attentional resources. As a result, he would become so absorbed or consumed by anxiety that he would be distracted and unable to effectively engage in conversation with others. This individual would feel very bothered the anxiety, viewing it as unacceptable and something that needed to be changed in order to enjoy the party. Thus, he might attempt to regulate this anxiety by consuming alcohol to eliminate or suppress it or by leaving the situation to avoid feeling anxious, despite the fact that these strategies might carry negative long-term consequences (e.g., alcohol use problems, lack of social relationships).

Distress tolerance has been identified as a key factor in the development and maintenance of numerous forms of psychopathology (Zvolensky & Hogan, 2013; Zvolensky, Vujanovic, Bernstein, & Leyro, 2010). Indeed, recent work indicates that low levels of distress tolerance are associated with greater levels of anxiety psychopathology (i.e., post-traumatic stress disorder, panic, obsessive-compulsive, and social anxiety symptoms), depressive
symptoms, disordered eating, borderline personality disorder, and substance use behaviors (Bornovalova et al., 2008; Brandt, Zvolensky, & Bonn-Miller, 2012; Gratz et al., 2006; Keough, Riccardi, Timpano, Mitchell, & Schmidt, 2010; Leyro, 2010; Marshall-Berenz, Vujanovic, Bonn-Miller, Bernstein, & Zvolensky, 2010; Marshall-Berenz, Vujanovic, & Zvolensky, 2011; Timpano, Buckner, Richey, Murphy, & Schmidt, 2009; Vujanovic, Bonn-Miller, Potter, Marshall, & Zvolensky, 2011; Vujanovic, Bernstein, & Litz, 2011). In terms of substance use, specifically, low levels of distress tolerance are associated with greater frequency of substance use as well as substance use motives related to coping with negative emotions or situations (Leyro et al., 2010). Distress tolerance has also been found to mediate the relationship between depressive symptoms and substance use, providing further support for the idea that it is the inability to withstand negative emotions, rather than the negative emotions themselves, which motivates and maintains substance use behaviors (Buckner, Keough, & Schmidt, 2007).

**Distress Tolerance and Smoking**

In general, smokers have lower levels of distress tolerance than non-smokers. For example, smokers demonstrate shorter task persistence during behavioral tasks of distress tolerance (e.g., anagrams, mirror-tracing) compared to non-smokers, even after controlling for the effects of demographic variables, verbal intelligence, negative affect, and other substance use problems (Quinn, Brandon, & Copeland, 1996). Among smokers, lower levels of distress tolerance are further associated with a greater number of years as a smoker and higher levels of nicotine dependence (Brandon et al., 2003; Leyro, Bernstein, Vujanovic, McLeish, & Zvolensky, 2011). Smokers who are low in distress tolerance also tend to smoke more and report greater cravings than smokers high in distress tolerance when experiencing a negative mood, especially when the negative mood is caused by nicotine deprivation (e.g., as opposed to negative images or public speaking; Perkins, Giedgowd, Karelitz, Conklin, & Lerman, 2012; Volz et al., 2014). Indeed, low levels of distress tolerance are associated with greater negative affect.
reduction smoking expectancies; that is, smokers low in distress tolerance believe smoking will help them regulate or reduce negative emotions (Leyro et al., 2011).

Extant research indicates that distress tolerance is also associated with smoking cessation outcomes. Compared to their high distress tolerance counterparts, smokers with low distress tolerance report greater internal barriers to smoking cessation (e.g., increased anger, feeling less in control of their emotions without cigarettes), above and beyond the effects of smoking rate and other smoking maintenance factors (i.e., anxiety sensitivity; Kraemer, McLeish, Jeffries, Avallone, & Luberto, 2013). In an experimental study of adult smokers, those who were never able to successfully quit for more than 24 hours showed shorter task persistence on distressing tasks as well as greater depressive symptoms, than smokers who reported being able to successfully quit for at least three months (Brown, Lejuez, Kahler, & Strong, 2002). When returning for a second study visit after a 12-hour period of nicotine deprivation, participants who were low in distress tolerance reported greater smoking urges and increases in dysphoria (Brown et al., 2002).

Smokers who are low in distress tolerance are less likely than those high in distress tolerance to successfully quit smoking without treatment. In a prospective study of distress tolerance and early smoking lapse, smokers low in distress tolerance demonstrated a greater risk of relapse over the 28-day period following their intended quit day (Brown et al., 2009). Similarly, Abrantes and colleagues (2008) found that smokers attempting to quit without assistance who were low in distress tolerance were more likely to lapse on their quit day (i.e., not achieve abstinence), as well as report higher levels of negative affect and smoking urges on their quit day. Additionally, those low in distress tolerance and high in negative affect demonstrated the greatest risk of early relapse, indicating that the ability to withstand the negative emotions associated with a quit attempt, particularly when those negative emotions are fairly frequent and/or intense, is important for smoking cessation outcomes (Abrantes et al., 2008). In another prospective study of distress tolerance and time to smoking relapse, greater
duration of persistence on distressing tasks was associated with a greater number of hours until smoking relapse (Cameron, Reed, & Ninnemann, 2013).

Low distress tolerance smokers are also less likely to participate in formalized smoking cessation treatment programs, further reducing their chances of successfully quitting smoking (Brandon et al., 2003; MacPherson, Stipelman, Duplinsky, Brown, & Lejuez, 2008). For example, in a small sample of smokers who agreed to participate in a smoking cessation intervention and who completed the baseline assessment, those with a shorter duration of persistence on distress tolerance tasks were less likely to return to participate in the smoking cessation treatment (MacPherson et al., 2008). When they do participate in cessation interventions, smokers who are low in distress tolerance are less likely to complete the program (Hajek, 1987). Moreover, even if they do complete the program, low distress tolerance smokers have a greater risk of relapse over a one-year period (Brandon et al., 2003).

Taken together, empirical work on distress tolerance and smoking indicates that distress tolerance plays an important role in motivating and maintaining smoking behavior. As a group, smokers report low levels of distress tolerance, and they tend to rely on smoking to reduce or avoid emotional distress. The fact that smoking serves an affect regulatory function inherently compromises smoking cessation attempts, as these low distress tolerance smokers are unable to tolerate the negative affect that arises during withdrawal without the use of cigarettes. Thus, teaching smokers skills that result in increased tolerance for emotional distress is critical for promoting smoking cessation efforts.

**Mindfulness**

Mindfulness is one technique that may be effective in increasing distress tolerance among smokers. Mindfulness involves the self-regulation of attention toward, and non-judgmental awareness of, present moment experiences (Bishop, et al., 2004). Mindfulness originated over 2,500 years ago in Eastern meditative (i.e., *Vipassana*) traditions and is derived from the Pali word *sati*, which means awareness, attention, and remembering (Siegal, Germer,
& Olendzki, 2009). The most commonly used formal definition describes mindfulness as “paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally” (Kabat-Zinn, 2004; p. 4). Thus, mindfulness is a “way of being” characterized by intentionally bringing an open, accepting, and curious awareness back to the present moment whenever the mind inevitably wanders (Sears et al., 2011).

According to mindfulness theory, the mind creates a constant, uninterrupted stream of mental events, and attempts to eliminate aversive thoughts or emotions are therefore inherently futile. Thus, the most effective way to reduce suffering with these thoughts or emotions is to change one’s relationship with them, rather than their content (Didonna, 2009). For example, mindfulness is thought to help individuals experience a depressive thought (e.g., “I am not good”) as a mental event separate from the self, which may or may not reflect reality, rather than encourage individuals to actively try to change the thought (e.g., “I am great the way I am”). Mindfulness requires cultivation through formal (i.e., sitting meditation, walking meditation) and informal meditation practices (e.g., mindfully brushing one’s teeth or washing dishes), with the goal of becoming more aware of present moment experiences.

Increasing one’s ability to be mindful has long been considered an effective way to promote psychological well-being (Gunaratana, 1990). Greater mindfulness has been found to be associated with lower levels of numerous forms of psychopathology, including anxiety, depression, anger, dissociation, rumination, alexithymia, difficulties in emotion regulation, experiential avoidance, and intensity of psychotic delusions (Greeson, 2009; Keng, Smoski, & Robins, 2011). Higher levels of mindfulness have also been associated with a wide range of positive outcomes, including increased life satisfaction, quality of life, well-being, self-esteem, optimism, self-compassion, and positive affect (Baer & Lykins, 2011; Greeson, 2009; Keng et al., 2011). Moreover, mindfulness is associated with better physical health and fewer health risk behaviors, such as substance use and abuse (Brewer, Elwafi, & Davis, 2013; Gilbert & Waltz, 2010; Katz & Toner, 2013; Keng et al., 2011). For example, greater mindfulness is associated
with decreased alcohol consumption and fewer alcohol use problems among college students (Baer, 2012; Murphy & Mackillop, 2012; Eisenlohr-Moul, Walsh, Charnigo, Lynam, & Baer, 2012; Fernandez, Wood, Stein, & Rossi, 2010).

Given the utility of mindfulness in improving health and mental health outcomes, increased research attention has recently focused on examining the efficacy of brief mindfulness interventions. Typically these brief interventions are 10-15 minute, single-session interventions that usually teach a mindfulness exercise, such as mindful breathing or the body scan. These exercises involve noticing an object of awareness (e.g., physical sensations in different parts of the body, physical sensations associated with the breath) with openness and acceptance and, when the mind wanders, acknowledging the distractions without judgment and gently returning the mind back to the intended object (Sears et al., 2011). Previous studies have found that, compared to other cognitive-affective tasks (e.g., rumination, distraction, problem-solving) or neutral control exercises (e.g., quiet sitting, listening to audio recordings of neutral topics), brief mindfulness exercises are associated with immediate improvements in positive and negative affect (Diaz, Jimenez, & Lopes 2014; Broderick, 2005), attentional control (Friese, Messner, & Schaffner, 2012), rumination (Hilt & Pollak, 2012), negative bias (Alberts & Thewissen, 2011), pain tolerance (Liu, Wang, Chang, Chen, & Si, 2012; McMullena et al., 2008), eating behavior (Marchiori & Papies, 2014), prosocial behavior (Heppner et al., 2008; Ramsay & Jones, 2015) emotional reactivity (Erisman & Roemer, 2010), behavioral avoidance (Hooper, Davies, Davies, & McHugh, 2011), state mindfulness (Vinci et al., 2014; Garland, Hanley, Farb, & Froeliger, 2015) and physiological functioning (e.g., blood pressure and neural activity; Larson, Steffen, & Primosch, 2013).

**Mindfulness and Smoking**

Research on trait mindfulness and smoking has found that greater levels of mindfulness are associated with several important predictors of successful smoking cessation, including lower levels of nicotine dependence, less severe nicotine withdrawal, and greater self-efficacy...
for smoking abstinence (Vidrine et al., 2009). Results of prospective studies show that greater levels of mindfulness even predict lower levels of emotional reactivity and depressive symptoms during a subsequent quit attempt (Adams et al., 2014). Indeed, mindfulness is also associated with fewer emotional problems among smokers. For example, greater levels of mindfulness are associated with a greater ability for smokers to de-identify with depressive stimuli on implicit association tasks (Waters et al., 2009). That is, smokers higher in mindfulness are less likely to associate self-referential words (e.g., “I”, “me”) with depressive words (e.g., “sad,” “lonely”) than smokers lower in mindfulness. This ability to separate depressive words from one’s sense of self is important, as it suggests that these smokers are able to experience negative affective states as passing objects in their awareness, rather than become entangled with them in a downward emotional spiral.

Results of recent systematic reviews suggest that mindfulness-based interventions are effective treatments for a range of substance use disorders, including cigarette smoking (Chiesa & Serretti, 2014), and there is a growing body of literature examining the efficacy of brief mindfulness interventions in terms of smoking cessation outcomes. For example, Cropley, Ussher, and Charitou (2007) randomly assigned smokers to a brief mindfulness training (i.e., body scan) or control condition (i.e., listen to an audio recording of a passage from a natural history text) after a 12-hour abstinence period. Findings from this study indicate that those in the mindfulness training condition reported decreased irritability, tension, restlessness, and desire to smoke compared to smokers in the control condition (Cropley et al., 2007). Similarly, Westbrook and colleagues (2013) conducted a neuroimaging study of smokers’ responses to viewing neutral and smoking-related computer images. Those who were instructed to view the images mindfully rather than passively reported fewer cravings in response to the smoking-related images and showed reduced neural activity and functional connectivity between craving-related brain regions. Lastly, in a study among nicotine deprived female smokers, the association between negative affect and negative affect reduction smoking motives was no
longer significant for the group that received mindfulness instructions to focus on their breath with non-judgment and acceptance compared to those who did not receive such instructions (Adams et al., 2013).

Mindfulness training has even been found to outperform the use of specific emotion regulation strategies in terms of improving smoking and emotional outcomes. Rogojanski and colleagues (2011) conducted an experimental study that examined the effects of mindfulness compared to suppression during a cue-exposure task. Results indicated that while both groups smoked significantly fewer cigarettes over a one-week follow-up period and reported increased self-efficacy for smoking abstinence, only the mindfulness group reported decreases in negative affect, depressive symptoms, and nicotine dependence during the one-week follow-up period. Randomized controlled trials comparing mindfulness training to standard smoking cessation interventions (e.g., the American Lung Association’s Freedom from Smoking intervention) have similarly found unique benefits of mindfulness in terms of reduced smoking urges and better emotional functioning (Davis, Manley, Goldberg, Smith, & Jorenby, 2014).

Moreover, mindfulness-based smoking cessation interventions demonstrate greater efficacy than standard smoking cessation interventions. Indeed, mindfulness-based interventions show relatively high six-week abstinence rates (56%; Brewer et al., 2011), and significantly higher two-week (20% vs. 4%; Davis, Mills, Stankevitz, Manley, Majeskie, & Smith, 2013) and 17-week abstinence rates as compared to other cognitive-behavioral smoking cessation interventions (31% vs. 6%; Davis, Fleming, Bonus, & Baker, 2007). Recent studies have even found significantly higher abstinence rates at six-month follow-up for smokers who received mindfulness training as compared to those who received nicotine replacement therapy and access to supportive counseling (39% vs. 21%; Davis, Goldberg, Anderson, Manley, Smith, & Baker, 2014).

In sum, these findings indicate that mindfulness is an adaptive skill for smoking and emotional outcomes. Mindfulness is associated with decreases in smoking behavior,
improvements in smoking-related cognitive processes (e.g., self-efficacy for smoking abstinence, negative affect reduction smoking expectancies), and decreases in emotional risk factors related to poor cessation outcomes (e.g., negative affect, nicotine dependence). Theoretically, one important way mindfulness reduces smoking behavior is through improvements in emotional risk factors, particularly distress tolerance (Abrantes et al., 2008; Bowen & Marlatt, 2009; Breslin, Zack, & McMain, 2002; Katz & Toner, 2013).

**Mindfulness and Distress Tolerance**

Mindfulness training is widely used as an integral part of clinical interventions, particularly Dialectical Behavioral Therapy (DBT), to increase distress tolerance (Linehan, 1993). Indeed, improvements in distress tolerance are considered a “natural progression” from the use of mindfulness skills, as mindfulness training teaches individuals to notice emotions without judgment and to let them naturally occur on their own without efforts to eliminate or avoid them (Linehan, 1993, p. 147). Empirical research supports this line of thinking. For example, in a non-clinical sample of adults, greater mindfulness was associated with greater distress tolerance (Vujanovic, Bonn-Miller, Bernstein, McKee, & Zvolensky, 2010). Among individuals with borderline personality disorder, mindfulness instructions presented as statements on a computer screen (e.g., “Notice any sensations in your body without judging them as good or bad”) are associated with longer persistence on a distressing math task following a negative mood induction (Sauer & Baer, 2012). In a recent randomized trial of mindfulness training for non-clinical young adults, individuals in the mindfulness condition reported increases in distress tolerance, which were related to increases in levels of mindfulness (Lotan, Tanay, & Bernstein, 2013).

Greater mindfulness has also been found to be associated with greater distress tolerance among individuals with substance use disorders, including cigarette smoking. In a randomized controlled trial comparing Mindfulness-Based Relapse Prevention (MBRP) to treatment as usual among adults with substance use disorders other than nicotine dependence,
those who were low in baseline distress tolerance and received mindfulness training showed greater improvements than those low in distress tolerance who received treatment as usual (Hsu, Collins, & Marlatt, 2013). These findings suggest that mindfulness-based interventions may be particularly useful for those low in distress tolerance, and that there may be clinical utility in matching low distress tolerance substance users with mindfulness-based treatment programs. In a recent study of associations between mindfulness and distress tolerance among regular smokers, Luberto and colleagues (2013) found that greater use of mindfulness skills, particularly awareness and acceptance, significantly predicted increased distress tolerance, accounting for 35% of unique variance. It is noteworthy that these significant effects were found even after controlling for the variance accounted for by gender, negative affect, daily smoking rate, and education.

Recently, researchers have developed an acceptance-based distress tolerance smoking relapse prevention program with promising results. This intensive eight-week program combines individual and group therapy with pharmacological interventions (i.e., nicotine replacement therapy), psychoeducation, traditional cognitive behavior therapy (CBT) components (e.g., exposure therapy, identifying triggers), and Acceptance and Commitment Therapy (ACT) components (e.g., values clarification, acceptance; Brown et al., 2008). Preliminary results indicate that the participants, who had previously been unable to abstain from smoking for longer than 72 hours in the past ten years, achieved an average of 24 continuous days of smoking abstinence throughout course of the study (Brown et al., 2008). Although this program utilizes more general acceptance techniques rather than actual mindfulness meditation trainings to increase distress tolerance, these findings provide indirect support for the efficacy of mindfulness training in improving distress tolerance among smokers given the critical acceptance component of mindfulness.

**Conclusions and Limitations of Past Research**
Taken together, low distress tolerance is associated with poor smoking outcomes, and mindfulness training is associated with improved smoking outcomes. Mindfulness training is widely used in clinical practice, and extant research indicates that greater mindfulness is associated with greater distress tolerance in several populations, including smokers. In fact, improvements in distress tolerance are considered to be an important mechanism by which mindfulness exerts its effects on smoking outcomes (Bowen et al., 2009; Abrantes et al., 2008).

Mindfulness is thought to improve affect regulation processes, including distress tolerance, for two key reasons. First, mindfulness is thought to promote greater awareness of smoking triggers (e.g., cravings, negative affect), but with a quality of acceptance and non-reactivity that promotes a more conscious, rather than automatic, behavioral response (Bowen et al., 2009; Witkiewitz, Marlatt, & Walker, 2005). This process, referred to as “de-centering,” teaches individuals to simply notice internal events as they occur without over-identifying with them, taking them literally as a fact (e.g., that the thought “I need a cigarette” truly means that one needs a cigarette), or feeling the need to alter or avoid them (Lynch & Mizon, 2011; Linehan, 1993). In line with this idea, recent studies have found that following mindfulness training, there is no longer a significant relationship between cigarette cravings and smoking behavior, suggesting that mindfulness decouples the relationship between smoking-related emotions and behavior (Elwafi, Witkiewitz, Mallik, Thornhill, & Brewer, 2013). Second, given that mindfulness involves simply noticing and accepting aversive emotions, it is also thought to serve as a form of exposure to negative emotions (Holzel et al., 2011; Sears, 2011). This process is important, as exposure therapy is a classic, evidence-based cognitive-behavioral approach for effectively treating fear and anxiety (Chambless & Ollendick, 2001). Therefore, the skills developed through mindfulness practice are thought to teach smokers effective ways to experience and withstand aversive thoughts and emotions, thereby decreasing the need to use substances in order to reduce negative affect (Abrantes et al., 2008; Bowen et al., 2009).
However, no study, to date, has directly examined the actual effects of mindfulness training on distress tolerance among smokers. Although mindfulness trainings have been shown to improve smoking and other emotional outcomes, and mindfulness is related to distress tolerance among smokers via self-report, it remains unclear the extent to which mindfulness training impacts smokers’ actual behavior when experiencing emotional distress. Additionally, mindfulness-based smoking cessation programs are generally intensive and time-consuming, while brief mindfulness exercises have been effective in improving smoking and emotional outcomes (other than distress tolerance) among smokers. The lack of research attention focused specifically on mindfulness training for distress tolerance among smokers is unfortunate, because it prevents us from properly understanding the mechanisms by which mindfulness exerts its effects, as well as from identifying brief evidence-based methods for improving distress tolerance among smokers.

**The Present Study**

Therefore, the purpose of the present study was to determine the effects of a brief mindfulness training exercise on distress tolerance, smoking urges, levels of subjective distress, and state mindfulness among regular daily smokers. It was hypothesized that, after controlling for the effects of gender, baseline negative affect, daily smoking rate, and meditation experience, smokers who participated in the brief mindfulness training exercise, compared to smokers in the control condition, would demonstrate (1) increased self-reported (i.e., Distress Tolerance Scale) and behavioral (i.e., task persistence on Mirror-Tracing Persistence Task and voluntary hyperventilation) distress tolerance; (2) fewer smoking urges; (3) greater decrease in levels of subjective distress (i.e., Subjective Units of Distress Scale ratings); and (4) a greater increase in state mindfulness (i.e., State Mindfulness Scale). The covariates were chosen on an *a priori* basis due to their documented associations with both distress tolerance (Leyro et al., 2011; MacPherson et al., 2008; Simons & Gafer, 2005) and mindfulness (Jislin-Goldberg, Tanay, & Bernstein, 2012; Keng, 2011).
Method

Participants

Participants were 91 regular daily smokers recruited from the community. One participant was removed from the study due to apparent intoxication, one was removed due to not having met eligibility criteria (i.e., not meeting the cut-off for carbon monoxide levels), and three were removed for being statistical outliers (see results section below). Thus, the final sample consisted of 86 participants. See Table 1 for complete demographic characteristics for the full sample and each experimental group. Participants were, on average, 46.03 years old, \((SD = 9.97)\), male (54.6\%) and African American (74.1\%). Participants smoked an average of 18 cigarettes per day \((SD = 8.79)\) and had been regular smokers for an average of 25.57 years \((SD = 10.12)\). Mean level of nicotine dependence was 3.51 \((SD = 1.59)\), indicating mild levels of nicotine dependence. Approximately one-third of the sample reported a lifetime history of meditation experience.

Measures

Substance Use-related Measures

Expired carbon monoxide. Biochemical verification of smoking status was completed by carbon monoxide (CO) analysis of breath samples assessed using a Bedfont Micro 4 Smokerlyzer CO Monitor (Model EC50; coVita, Haddonfield, NJ). Research indicates that 8 ppm is an optimal cut-off score for reliably discriminating smoking status (Jarvis, Tunstall-Pedoe, Feyerabend, Vesey, & Saloojee, 1987). Obtained values at or above this cutoff were considered indicative of regular smoking.

Smoking History Questionnaire (SHQ). The SHQ (Brown et al., 2002) is a self-report measure that assesses smoking history and pattern, including age of smoking onset, number of years as a smoker, current smoking rate, and history of quit attempts. The SHQ has been successfully used in previous studies to assess smoking history (McLeish, Zvolensky, Smits, Bonn-Miller, & Gregor, 2007; Zvolensky & Bernstein, 2005; Zvolensky, Lejuez, Kahler, & Brown,
The SHQ was administered at baseline to gather descriptive data about the sample and daily smoking rate was used as a covariate.

**Fagerström Test for Nicotine Dependence (FTND).** The FTND is a 6-item self-report measure that assesses level of nicotine dependence (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991). It is a revised and shortened version of the Fagerström Tolerance Questionnaire (FTQ; Fagerström, 1978). The FTND has shown good internal consistency, positive relations with key smoking variables (e.g., saliva cotinine), and high degrees of test-retest reliability (Heatherton, Kozlowski, Frecker, Fagerstrom, 1991; Heatherton et al., 1991; Payne, Smith, McCracken, McSherry, & Antony, 1994; Pomerleau, Carton, Lutzke, Flessland, & Pomerleau, 1994). The FTND was administered at baseline as a descriptive index and not employed in the analyses.

**Questionnaire of Smoking Urges-Brief (QSU-Brief).** The QSU-Brief (Cox, Tiffany, & Christen, 2001) is a 10-item measure of current moment smoking urges. It is comprised of the 10 items that loaded most strongly on the original 32-item Questionnaire of Smoking Urges (Tiffany & Drobes, 1991). Items are rated on a scale of 0 (strongly disagree) to 100 (strongly agree), with higher scores indicating greater smoking urges. The QSU-Brief contains a higher-order smoking urges factor with two lower-order factors that reflect (1) the intention to smoke (e.g., “I have a desire for a cigarette right now”) and (2) the desire to relieve negative affect by smoking (e.g., “Smoking would make me less depressed”). These two factors are highly intercorrelated (e.g., $r = .80$) and load strongly on the higher order factor (e.g., $b$-weight = .89; Cox, Tiffany, & Christen, 2001). Additionally, internal consistency reliability is higher for the full 10-item scale (e.g., $\alpha = .97$) than either of the subscales (e.g., $\alpha = .78$ to .86;), and the full scale is strongly positively correlated with the original 32-item measure as well as with negative affect and smoking motives (Cox et al., 2001). Thus, using the QSU-Brief total score is recommended. In the current study, the QSU-Brief was administered following each of the distress tolerance
tasks, and the total score was used as an outcome measure. The total score showed excellent
internal consistency in the current sample ($\alpha = .96$ to $.97$).

**Alcohol Use Disorders Identification Test (AUDIT).** The AUDIT is a 10-item measure
assessing the frequency, quantity, and negative consequences of alcohol use (Babor et al.,
1992). The AUDIT was developed by the World Health Organization as a screening measure for
early identification of individuals with alcohol-related problems. A strong and well-established
body of literature supports the psychometric properties of the AUDIT, including positive
correlations with other alcohol use measures and biological indicators of heavy drinking, and the
ability to discriminate between hazardous and non-hazardous drinkers (Bohm Babor, Kranzler,
1995; Saunders et al., 1993). The AUDIT was used to ensure that there were no group
differences in alcohol use problems. It had excellent internal consistency ($\alpha = .91$).

**Distress Tolerance-related Measures**

**Distress Tolerance Scale (DTS).** The DTS (Simons & Gaher, 2005) is a 14-item self-
report measure that assesses one’s perceived ability to tolerate negative emotional states (e.g.,
“I’ll do anything to avoid feeling distressed or upset”). Items are rated on a 5-point Likert-type
scale (1 = *strongly agree* to 5 = *strongly disagree*) with higher scores indicating greater levels of
distress tolerance. The DTS shows strong psychometric properties including acceptable internal
consistency reliability ($\alpha = .89$), good test-retest reliability over a six-month period ($r = .61$), and
good convergent validity with negative affect, emotion regulation, and substance use variables
(Simons & Gaher, 2005). Additionally, among smokers, specifically, the DTS has demonstrated
strong psychometric properties in terms of internal consistency reliability ($\alpha = .91$) and
convergent validity with negative affect and smoking outcomes (Leyro et al., 2011). The DTS
was used in the current study as a self-report index of distress tolerance and was administered
before and after the mindfulness exercise/control condition. Chronbach’s alpha for the DTS in
the current sample was good for both the pre- ($\alpha = .87$) and post-experimental ($\alpha = .86$)
administrations.
**Mirror-Tracing Persistence Task- Computerized (MTPT-C).** The MTPT-C (Daughters et al., 2005; Quinn, Brandon, & Copeland, 1996; Strong et al., 2003) is a behavioral measure of distress tolerance. Participants are asked to use the computer mouse to trace a series of figures on a computer screen as if viewing them through a mirror. That is, the cursor on the computer screen moves in the opposite direction from the movement of the mouse. The participant is given three different figures of increasing difficulty to trace (i.e., a straight line, two perpendicular lines, and a star). If the participant moves the mouse too slowly, stops moving the mouse, or moves off the outline of the figure, it creates a distressing buzzing sound and the task restarts. The participant must complete the first two figures within thirty seconds. The last figure is more challenging, and the participant is instructed that they have the option to terminate the task at any time. The task automatically terminates if the participant has not ended the task within 10 minutes. The amount of time spent on the last figure before termination is used as an index of distress tolerance (Daughters et al., 2005), with longer task persistence indexing greater distress tolerance. The MTPT-C task has been used in several studies of distress tolerance to successfully induce distress (Leyro et al., 2010). It also is significantly correlated with other behavioral measures of distress tolerance (Marshall-Berenz et al., 2010; Zvolensky, 2010). The MTPT-C was chosen as opposed to other behavioral distress tolerance tasks because it eliminates some potential confounds (e.g., effects of math ability on serial addition tasks). The MTPT-C served as a behavioral index of distress tolerance and was administered before and after the mindfulness exercise/control condition.

**Voluntary Hyperventilation Task.** The voluntary hyperventilation task is a behavioral measure of the ability to tolerate distressing physical sensations. Participants are asked to over-breathe at a consistent rate that exceeds metabolic demands, thereby inducing a mild state of hyperventilation. In the current student, participants were asked to take full, deep breaths along with an audio recording at a rate of one full breath every two seconds (i.e., inhale on second one and exhale on second two; Leyro et al., 2011). The researcher first reviewed these
instructions, demonstrated the task, and then asked the participant to briefly practice the task along with a recording of a metronome set to the appropriate tempo (i.e., 60 beats per minute). After the instructions and practice, participants were asked to do their best to breathe along with the recording for as long as they could, and were informed that they could end the task at any time. The recording terminated after three minutes to ensure participant safety (Leyro et al., 2011). Distress tolerance is measured as the duration of task persistence, with longer duration indicating greater distress tolerance. This task has been used in several studies of distress tolerance and is shown to correlate with self-reported measures of distress tolerance, greater levels of anxious responding to somatic discomfort, and problematic substance use (Leyro et al., 2011; Buckner et al., 2007). It is also shown to successfully induce physiological arousal in smokers (Marshall et al., 2008). The voluntary hyperventilation task was administered before and after the mindfulness/control condition in order to provide an index of the effects of mindfulness on physical (i.e., as opposed to only emotional) distress tolerance.

**Subjective Units of Distress (SUDS).** The SUDS is a self-report scale used to index intensity of distress (Wolpe, 1969). Participants are asked to indicate on a 100-point scale ranging from 0 (no distress) to 100 (extremely distressed) how distressed they feel at the current moment. SUDS ratings are commonly and successfully used in psychopathology research to examine changes current moment distress associated with a laboratory stressor (e.g., Feldner et al., 2006; Spira, Zvolensky, Eifert, & Feldner, 2004; Schmidt, Maner, & Zvolensky, 2007). SUDS ratings were obtained before and after the distress tolerance task and before and after the mindfulness exercise/control condition to ensure that the distress tolerance task successfully produced distress and that the mindfulness exercise/control condition does not produce distress (i.e., manipulation check).

**Mindfulness Measures**

**Meditation Experience Questionnaire (MEQ).** A self-report measure of history of meditation experience was developed for the current study. This measure was created based
on the description of similar researcher-developed measures used in previous studies (Jislin-Golberg, Tanay, & Bernstein, 2012). The MEQ used in the previous study contained six items assessing history of any meditation experience (“Have you ever practiced meditation?”) and, for those who endorsed ever practicing meditation, the form (e.g., mindfulness meditation, transcendental meditation), frequency, and context of practice (e.g., independently with a recording, in yoga classes). Only the history of previous experience question was used in the current study to ensure that there were no group differences in meditation experience.

**State Mindfulness Scale (SMS).** The SMS (Tanay & Bernstein, 2013) is a 21-item measure of levels of mindfulness in the current moment. The SMS asks participants to indicate on a 5-point scale (1= not at all to 5 = extremely) the extent to which each item applied to them while they participated in a specific activity; thus, it is a context-specific measure of mindfulness that assesses levels of mindfulness during a particular task. The SMS is shown to contain one higher-order state mindfulness factor and two lower-order factors: (1) mindfulness of body (e.g., “I noticed physical sensations come and go”) and (2) mindfulness of mind (e.g., “I noticed pleasant and unpleasant thoughts”). These factors are moderately positively correlated ($r = .56, p < .01$) and load strongly onto the higher-order factor (-.99 and -.74), suggesting that a total score may also be used (Tanay & Bernstein, 2013). In the initial validation study, the only examination of the SMS to date, the total score ($\alpha = .95$) and subscale scores ($\alpha = .95$ and .90) showed good internal consistency reliability, context-dependent test-retest reliability ($r = .65, p < .01$), convergent and discriminant validity with other self-report measures of mindfulness, construct validity in terms of sensitivity to change following mindfulness exercises, and predictive validity in terms of enhanced levels of dispositional mindfulness over time (Tanay & Bernstein, 2013). In the current study, the SMS-total score was employed before and after the mindfulness/control exercises to be used as a manipulation check. It showed excellent internal consistency both before ($\alpha = .91$) and after ($\alpha = .95$) the mindfulness/control exercise.

**Procedure**
An overview of the study procedure can be seen in Figure 1. Participants were recruited via advertisements placed in public areas, local newspapers, and on community-oriented websites (e.g., Craigslist). Individuals were eligible to participate if they: (a) were between the ages of 18 and 65; (b) had been a daily smoker for at least one year; (c) smoked an average of at least 8 cigarettes per day; and (d) met biochemical cut-off values for current regular smoking (i.e., expired carbon monoxide levels \( \geq 8 \) ppm; please see Measures section for details). Participants were required to have been smoking for at least one year to reduce potential confounds associated with differences in smoking patterns between beginning and established smokers (Asfar, Ward, Eissenberg, & Maziak, 2005). Participants were excluded from the study based on evidence of: (a) limited mental competency and the inability to give informed, written consent; (b) use of other tobacco products; or (c) a decrease of smoking rate by more than half in the past six months. These exclusionary criteria were put in place to ensure participant safety and ethical research procedures as well as to avoid confounds associated with the use of different tobacco products (O’Conner et al., 2007) and changes in smoking patterns associated with smoking cessation (DiClemente et al., 1991).

Initial screening procedures were completed via telephone. Interested individuals were given a brief description of the study and then administered a brief phone screen to determine eligibility. Potentially eligible participants were then scheduled for an individual study visit. Upon arrival, participants first provided informed, written consent. Then, smoking status was biochemically verified via CO analysis. Participants then completed the experimental portion of the study. First participants completed the first MTPT-C trial, rested for three minutes, and then completed the first hyperventilation trial. After a three-minute rest period, participants then either completed the mindfulness training exercise or the control condition exercise (see below for detailed descriptions of the two conditions; see appendices for scripts). Participants were randomly assigned to the mindfulness training or control group using block randomization (block size = 6). This strategy ensured that the sample sizes would be equal for each group, increasing
our statistical power (Efird, 2011). Following the mindfulness training or control exercise, participants rested for three minutes before completing the second MTPT-C trial, followed by a three-minute rest period, and then the second hyperventilation trial. Participants provided SUDS ratings before and after each MTPT-C and hyperventilation trial, as well before and after the mindfulness/control condition. Participants also completed the SMS and DTS before and after the mindfulness training/control condition, and the QSU after each MTPT-C and hyperventilation trial. After the experimental procedures, participants completed the following self-report measures: SHQ, FTND, AUDIT, and MEQ. Participants were compensated $30 for their time and effort.

**Mindfulness Training Condition.** Participants randomized to the mindfulness training condition participated in a 10-minute guided sitting meditation. A sitting meditation was chosen, because it (1) is a key exercise in many mindfulness-based interventions (e.g., Segal, Williams, & Teasdale, 2013; Bowen, Chawla, & Marlatt, 2011); (2) incorporates mindfulness of a full range of internal events as opposed to exercises that focus only on physical sensations (e.g., the body scan); (3) is cost effective by not requiring the use of props or other items; and (4) avoids difficulties associated with physical limitations of the participant by not requiring any movement. This brief mindful sitting exercise is similar to brief mindfulness trainings used successfully in other studies of mindfulness and emotional outcomes (Adams et al., 2013; Arch & Craske, 2006; Cropley et al., 2007; Erisman & Roemer, 2010; Feldman et al., 2010; Westbrook et al., 2013). The training took place in an 8-foot x 10-foot room consisting of a desk and a computer, two cushioned chairs, and a small table. A recording of a mindful sitting exercise adapted from other mindfulness-based interventions and empirical studies of mindfulness training (Segal et al., 2002; Erisman & Roemer, 2010) guided participants through the mindfulness training (please see Appendix A for a script of the mindfulness training exercise). The recording asked participants to remain seated in a comfortable position with their eyes closed for the duration of the exercise, and guided the participant’s attention to sequentially focus on their breath, their
body, environmental sounds, and their thoughts. The sitting meditation ended with mindfully observing the sensations of breathing before participants were asked to open their eyes.

**Control Condition.** Participants randomized to the control group listened to a 10-minute audio recording of a passage from a high school-level natural science textbook (Please see Appendix B for a script of the control condition recording). For the recording, the passage was read out-loud at a deliberate pace, tone, and cadence in order to mirror the recording of the mindfulness script and, thereby, aim to minimize any differences between the two conditions other than the actual recording content.

**Data Analytic Plan**

**Missing Data.** The primary study variables (i.e., negative affect, cigarettes per day, and hyperventilation, mirror-tracing, distress tolerance, state mindfulness, and smoking urges pre- and post-recording) were first examined for missing data. Variables with more than 5% missing data were further examined to determine whether or not data was missing at random (Tabacknick & Fidell, 2007). For variables that were found to be missing data not at random, multiple imputation procedures were used to replace the missing values (Tabacknick & Fidell, 2007).

**Descriptive Analyses.** The data was examined for normality, and any non-normally distributed variables were transformed. Normality was determined by examining whether or not skewness \((S)\) and kurtosis \((K)\) values were greater than three times the standard error for skewness \((SE_s)\) and kurtosis \((SE_k)\) for each variable (Tabacknick & Fidell, 2007). Variables were also examined for outliers as determined by individuals with z-scores greater than 3.29 for a given variable (Tabacknick & Fidell, 2007). Independent samples t-tests and chi-square tests as appropriate were used to compare the mindfulness and control groups on demographic variables, meditation experience, cigarettes per day, and baseline levels of substance use and distress tolerance. Any significant group differences were included as covariates in subsequent analyses.
Zero-order correlations. Zero-order correlations between all study variables were examined for the full sample to assess the basic relationships between the predictor and outcome variables.

Manipulation Checks. To confirm that the MTPT-C trials and hyperventilation trials successfully induced distress, paired-samples t-tests were used to compare SUDS ratings before and after the two MTPT-C trials and hyperventilation trials within the mindfulness and control groups separately.

Analysis of Variance (ANOVA). Next, 2x2 mixed-ANOVAs were used to test the hypotheses that brief mindfulness training produces improvements in distress tolerance, smoking urges, levels of subjective distress, and state mindfulness among smokers. Condition (mindfulness vs. control; between-subjects factor) and time (pre-recording vs. post-recording; within-subjects factor) were entered as independent variables and examined for their interaction and main effects. If there was a significant interaction, planned comparisons were conducted to test for significant improvements in distress tolerance from Time 1 (pre-recording) to Time 2 (post-recording) among the mindfulness group compared to control group using paired-samples t-tests within each group. Given the relatively small sample size, we also examined whether non-significant trends (p < .10) for interactions and main effects were in the expected directions. Partial eta-squared was used as an index of effect size and interpreted as, .01 = small, .06 = medium, and .14 = large (Cohen, 1977). Partial correlations were examined between changes in state mindfulness and changes in any primary outcome that improved over time in order to determine whether improvements in mindfulness were associated with improvements in distress tolerance.

Results

Descriptive Analyses

Missing Data. The cigarettes per day and state mindfulness variables were found to be missing greater than 5% of data not at random (i.e., missing data on these variables was
correlated with distress tolerance-related outcomes). Multiple imputation procedures were used to replace missing values on these variables (Tabachnick & Fidell, 2007).

**Normality.** Three univariate outliers were identified and removed prior to conducting the analyses. One outlier was identified on the first hyperventilation trial \((z = 3.47)\), and two were identified on the first mirror-tracing trials \((z = 4.10 \text{ and } 5.62)\). Negative affect \((S = 1.13, SE_s = .26, K = .97, SE_k = .52)\), cigarettes per day \((S = .83, SE_s = .26, K = .34, SE_k = .51)\), the first hyperventilation trial \((S = 1.23, SE_s = .26, K = .79, SE_k = .51)\), the second hyperventilation trial, \((S = 1.43, SE_s = .26, K = 2.35, SE_k = .51)\), the first MTPT-C trial \((S = 1.14, SE_s = .26, K = .61, SE_k = .51)\), and the second MTPT-C trial \((S = 1.61, SE_s = .26, K = 2.22, SE_k = .51)\) were all non-normally distributed. Transformations appropriate to the type and magnitude of skewness or kurtosis were applied to each of these variables in order to achieve normal distributions. Specifically, inverse transformation was used for negative affect, square root transformation was used for cigarettes per day, and MTPT-C pre- and post-recording, and log10 transformation was used for hyperventilation pre- and post-recording. The pattern of results did not differ when using the non-transformed and transformed variables; thus, for ease of interpretation only the results using the non-transformed variables are presented.

**Group Differences.** See Table 1 for demographic characteristics of each group. There were no significant differences between the mindfulness and control group in terms of gender \([X^2(1) = 3.08, p = .09]\), ethnicity \([X^2(1) = 1.04, p = .49]\), race \([X^2(4) = 1.06, p = .90]\), education \([X^2(6) = 2.88, p = .82]\), income \([X^2(7) = 3.05, p = .88]\), meditation experience \([X^2(1) = .02, p = .88]\), age \([t(84) = -.14, p = .89]\), negative affect \([t(83) = 1.75, p = .08]\), baseline DTS \([t(81) = -.93, p = .36]\), cigarettes per day \([t(84) = -.15, p = .88]\), nicotine dependence \([t(83) = .31, p = .76]\), or alcohol use problems \([t(80) = -1.06, p = .30]\). Thus, no covariates were used in the current study.

**Zero-order Correlations**
See Table 2 for zero-order correlations among study variables. For each variable, pre-recording scores were significantly positively correlated with post-recording scores (range: .45 to .81). Self-reported distress tolerance was not significantly correlated with any of the behavioral distress tolerance tasks. The behavioral distress tolerance tasks were significantly positively correlated with one another both pre- and post-recording (range: .28 to .57), with the exception of hyperventilation pre-recording and mirror-tracing pre-recording.

**Manipulation Checks**

Participants in the mindfulness group reported a significant increase in SUDS ratings after both the first \[t(42) = -7.25, p = .00; M_{pre-task} = 23.70, M_{post-task} = 56.00\] and second \[t(42) = 5.09, p = .00; M_{pre-task} = 29.95, M_{post-task} = 53.60\] mirror-tracing trials. Similarly, participants in the control group also reported significant increases in SUDS ratings after both the first \[t(41) = -9.39, p = .00; M_{pre-task} = 18.73, M_{post-task} = 55.23\] and second \[t(41) = -5.56, p = .00; M_{pre-task} = 29.93, M_{post-task} = 53.55\] mirror-tracing trials. Participants in both the mindfulness \[t(43) = -3.33, p = .00; M_{pre-task} = 31.90, M_{post-task} = 45.02\] and control \[t(40) = -3.09, p = .00; M_{pre-task} = 30.22, M_{post-task} = 42.02\] groups reported significant increases in SUDS ratings after completing the first hyperventilation trial. However, the second hyperventilation trial did not result in a significant increase in SUDS ratings in either the mindfulness \[t(43) = -.78, p = .44; M_{pre-task} = 39.56, M_{post-task} = 42.27\] or control group \[t(41) = -1.51, p = .14; M_{pre-task} = 33.52, M_{post-task} = 40.07\]. Given that the second hyperventilation trial did not significantly increase distress, this variable was not included as an outcome variable in any subsequent analyses.

**Analysis of Variance**

Descriptive statistics for outcomes by group and time are presented in Table 3, and results of the ANOVA analyses are presented in Table 4. For mirror-tracing, there was a significant main effect of time in the expected direction \[F(1) = 9.16, p = .00, \eta^2_{partial} = .10\]: both groups persisted longer on the first mirror-tracing trial compared to the second \(M_{T1} = 242.82\) vs. \(M_{T2} = 176.13\). However, there was no main effect of group \[F(1) = .49, p = .49, \eta^2_{partial} = .01\], nor
was there a significant time by group interaction \([F(1) = .75, p = .39, \eta^2_{\text{partial}} = .01]\). Please see Figure 2 for a graphical representation of these results.

In terms of self-reported distress tolerance, the main effect for time \([F(1) = 3.02, p = .09, \eta^2_{\text{partial}} = .04]\) approached significance and was in the expected direction, suggesting an overall improvement in self-reported distress tolerance across groups \((M_{T1} = 2.99 \text{ vs. } M_{T2} = 3.10)\).

There was not a significant main effect for group \([F(1) = .24, p = .63, \eta^2_{\text{partial}} = .00]\), nor was there a significant time by group interaction \([F(1) = 2.68, p = .11, \eta^2_{\text{partial}} = .03]\). Please see Figure 3 for a graphical representation of these results.

For smoking urges following the mirror-tracing tasks, there was not a significant main effect of time \([F(1) = 2.25, p = .14, \eta^2_{\text{partial}} = .03]\) or group \([F(1) = .11, p = .75, \eta^2_{\text{partial}} = .00]\), nor was there a significant time by group interaction \([F(1) = .22, p = .64, \eta^2_{\text{partial}} = .00]\). Please see Figure 4 for a graphical representation of these results.

For subjective levels of distress, the main effect of time \([F(1) = 3.30, p = .07, \eta^2_{\text{partial}} = .04]\) and the time by group interaction \([F(1) = 3.22, p = .08, \eta^2_{\text{partial}} = .04]\) approached significance and were in the expected direction. The was not a significant main effect for group \([F(1) = .08, p = .78, \eta^2_{\text{partial}} = .00]\). Post-hoc analyses of the time by group interaction indicated that levels of distress significantly decreased for the mindfulness group \([t(42) = 2.29, p = .03; M_{T1} = 32.37, M_{T2} = 23.91]\) after the recording, but not for the control group \([t(40) = .02, p = .99; M_{T1} = 29.73, M_{T2} = 29.68]\). Please see Figure 5 for a graphical representation of these results.

For state mindfulness, there were significant main effects for time \([F(1) = 10.23, p = .00, \eta^2_{\text{partial}} = .11]\), group \([F(1) = 10.77, p = .00, \eta^2_{\text{partial}} = .11]\), and a significant time by group interaction \([F(1) = 14.24, p = .00, \eta^2_{\text{partial}} = .15]\). Post-hoc analyses of the interaction indicated that levels of state mindfulness significantly increased for the mindfulness group \([t(43) = -4.75, p = .00; M_{T1} = 72.02, M_{T2} = 81.44]\), but not for the control group \([t(41) = .42, p = .67; M_{T1} = 67.59, M_{T2} = 66.82]\). Please see Figure 6 for a graphical representation of these results.

**Discussion**
The inability to tolerate negative emotional states is associated with poor smoking cessation outcomes (Brown et al., 2002; Brown et al., 2009; Cameron et al., 2013). Mindfulness training is one technique used to increase distress tolerance, and preliminary research suggests improvements in distress tolerance might be one mechanism by which mindfulness training increases the chances of successfully quitting smoking (Abrantes et al., 2008; Bowen & Marlatt, 2009). However, no research, to date, has examined whether mindfulness training actually increases distress tolerance in smokers. Thus, the purpose of the current study was to examine the effects of a brief mindfulness exercise on behavioral and self-reported distress tolerance, smoking urges, levels of subjective distress, and state mindfulness.

Self-reported and Behavioral Distress Tolerance Relationships

In the current study, self-reported distress tolerance was not correlated with any of the behavioral measures of distress tolerance, while the two behavioral distress tolerance tasks were generally correlated with one another. These findings are consistent with previous research indicating that self-report measures of distress tolerance tend to correlate with other self-report measures, and behavioral measures of distress tolerance are significantly correlated with one another; however, self-report and behavioral measures of distress tolerance do not tend to correlate with one another (Ameral et al., 2014; Magidson et al., 2014; McHugh et al., 2012; Bernstein, Marshall, & Zvolensky, 2011; Marshall-Berenz, Vujanovic, Bon-Miller, Bernstein, & Zvolensky, 2010). However, the mirror-tracing and voluntary hyperventilation tasks were not significantly correlated with one another before the mindfulness or control recording in the current study. This finding is in contrast to previous research and warrants further investigation.

State Mindfulness

As hypothesized, results of the current study indicated that the mindfulness training was associated with greater improvements in state mindfulness than the control group. It is worth noting that the size of this effect was quite large. This study is the first to demonstrate that a
brief mindfulness exercise produces immediate improvements in state mindfulness in smokers, which could have significant clinical implications for smoking cessation. For example, as mindful states provide enhanced opportunities for goal-directed behavior, inducing states of mindfulness in smokers might reduce smoking behavior by providing more frequent opportunities for consciously choosing not to smoke in certain situations (e.g., when feeling upset). Additionally, Garland and colleagues (2015) recently found that state mindfulness induced by a brief mindfulness exercise was prospectively associated with better cognitive reappraisal one week later in non-clinical adults. Thus, inducing mindful states in smokers might promote more adaptive thinking in general, or in relation to smoking cues, and thereby reduce urges to smoke in response to negative emotions or environmental triggers. Further research on the long-term effects of state mindfulness and smoking outcomes is needed to elucidate any such effects.

**Subjective Distress**

The current results also suggest that brief mindfulness exercises might reduce levels of subjective distress in smokers. Indeed, participants in the mindfulness group reported a decrease in distress over time while participants in the control group did not. While this interaction did not reach statistical significance, likely due to the relatively small sample size of the current study, it did show a small to medium effect size. The observed reductions in subjective distress for participants in the mindfulness group are consistent with the results of previous studies that have demonstrated reduced distress with brief mindfulness trainings in other populations (Diaz et al., 2014; Broderick, 2005). These findings are also consistent with previous research in smokers showing that brief mindfulness exercises reduce distress associated with nicotine withdrawal (Cropley et al., 2007), though they extend these findings by demonstrating potential improvements in distress in the context of engaging in distressing activities. Given that negative affect plays a salient role in smoking behavior (Copeland et al., 1995; Kenford et al., 2002), identifying effective methods for immediately reducing distress in the moment might improve smoking outcomes by reducing motivation to smoke for negative
affect reduction reasons. Thus, brief mindfulness exercises might be effective tools for smoking cessation to the extent that they reduce the amount of distress to be tolerated or managed by smoking.

**Self-reported Distress Tolerance**

Contrary to the hypothesis, the current results indicated a trend toward increased self-reported distress tolerance for both groups. Indeed, there was a small to medium main effect of time, wherein self-reported distress tolerance scores were higher after the mindfulness or control recording compared to before. This overall improvement in distress tolerance appears to be largely driven by improvements in the control group, though the interaction effect did not approach significance. Although the mindfulness training was expected to result in increased distress tolerance, it is less clear why the neutral control exercise would increase distress tolerance. One possible explanation for improved distress tolerance among participants in the control condition is that the neutral audio recording served as a distraction task that got their mind off of their emotions and thereby made them feel more confident in their ability to tolerate distress. That is, whereas participants in the mindfulness group were instructed to notice their internal experiences after having completed a series of distressing tasks, participants in the control group were able to turn their attention away from their internal experiences; doing so might have contributed to a greater perceived ability to tolerate emotions by reducing the salience of emotional experiences in the moment. Indeed, several studies support the benefits of distraction for improving cognitive and affective functioning (e.g., Hilt & Pollak, 2012). Future studies should examine factors that influence whether smokers benefit more from mindfulness or distraction tasks in terms of distress tolerance.

**Behavioral Distress Tolerance**

Also contrary to prediction, results indicated that the 10-minute mindfulness training was not associated with improvements in any behavioral distress tolerance outcome. Indeed, the main effect of time for the mirror-tracing task showed similar decreases over time for both
groups. That is, both groups persisted for a shorter duration on the second mirror-tracing task compared to the first mirror-tracing task, and mindfulness training did not affect this decrease in persistence (e.g., by resulting in a lesser decrease). These findings are in contrast to previous studies indicating that brief, single-session mindfulness trainings are associated with improvements in emotional outcomes and distress tolerance processes (Cropley et al., 2007; Liu et al., 2012; Erisman & Roemer, 2012). There are several possible explanations for these findings. First, it is possible that motivational factors impacted persistence on the distress tolerance tasks. Similar to previous research (Ameral et al., 2014; Feldman et al., 2014), to reduce motivation due to financial gain, participants were aware that they would receive the same monetary compensation for their participation, regardless of how long they persisted on any of the tasks. However, this design might also have resulted in a lack of motivation to persist in the task overall. Thus, participants may have learned from the first trial that the task was quite distressing and, without external motivation to try their best to complete it again, terminated the task sooner the second time. This explanation might also explain why the second hyperventilation trial did not successfully induce distress.

In fact, the extent to which behavioral distress tolerance tasks actually capture the cognitive, motivational, and emotional processes underlying distress tolerance has been questioned (Magidson et al., 2013). Indeed, one recent study of non-smokers found significant variability in participants’ reported reasons for discontinuing the mirror-tracing task, with 52% of the sample ending the task in order to escape discomfort, but 36% ending the task because they simply believed it was impossible (Ameral et al., 2014). One option for circumventing ecological validity issues would be to utilize more domain-specific behavioral tasks (Magidson et al., 2013). This approach could be particularly relevant for distress tolerance research, as the ability to tolerate distress might vary within an individual depending on the specific emotion (e.g., being better able to tolerate sadness than anger; Bernstein & Brantz, 2013; Magidson et al., 2013). In terms of smoking research, future studies might measure the latency to smoking
among nicotine-deprived smokers as they expose themselves to incrementally stronger smoking triggers (e.g., opening a pack of cigarettes, holding an unlit cigarette, putting the unlit cigarette to their mouth).

Another explanation for the unexpected results for the mirror-tracing task is that repeated administrations are not appropriate for this task in such a short time period. To our knowledge, this study is the first to utilize two mirror-tracing procedures in the same study visit to assess change in distress tolerance. Only one other study utilized the mirror-tracing task multiple times. This study administered the task over a longer (i.e., two-week) time period, and utilized a composite score of duration on mirror-tracing and another behavioral distress tolerance task, limiting the ability to draw conclusions about mirror-tracing in particular (Bornovalova, Gratz, Daughers, Hunt, & Lejuez, 2012). The current results suggest that administering the mirror-tracing task twice in a very short time period (i.e., 15-20 minutes) may not be not a valid approach for capturing improvements in behavioral distress tolerance. Given that different behavioral measures of distress tolerance are correlated with one another (Ameral et al., 2014; Bornovalova et al., 2012; Marshall-Berenz et al., 2010; Zvolensky, 2010), another option might be to utilize a different behavioral task before and after the intervention being examined. The novelty associated with the second task might help to engage participants more fully in the task.

Alternatively, it is possible that the “dose” of mindfulness in the current study was insufficient to produce acute effects on the mirror-tracing task. Given that mindfulness requires cultivation through repeated practice, and distress tolerance is relatively stable within a given context (Simons & Gaher, 2005; Cummings et al., 2013), one 10-minute training session may not be enough to improve long-standing beliefs or behavioral tendencies in tolerating distress. Rather, brief, single-session mindfulness exercises might be better suited to improving more state-like emotional outcomes (e.g., distress levels; Cropley et al., 2007), or emotional responding to less distressing stimuli (Erisman & Roemer, 2010). In line with these ideas, recent
research suggests that four weekly, 60-minute mindfulness training sessions combined with 15 minutes of practice four nights/week is a sufficient dose to effectively improve self-reported distress tolerance (Lotan et al., 2013). It is also possible, however, that a 10-minute mindfulness exercise could significantly improve distress tolerance, but that the size of the effect is smaller than anticipated, making the current study underpowered to detect a significant effect.

It should also be noted that the majority of participants in the current study were African-American, which might have also impacted the results. The over-representation of African-Americans is a strength of the current study, as it provides an opportunity to explore smoking-related risk factors in a particularly vulnerable group. Indeed, African-American smokers have more difficulties quitting and are at greater risk for negative health consequences of smoking compared to other racial groups (e.g., lung cancer; Fu et al., 2008; Haiman et al., 2006). However, it might also explain why the mindfulness training did not improve distress tolerance. Although there is an overall lack of research on racial differences in distress tolerance, there is indirect support for the idea that African-Americans might have higher levels of distress tolerance than other racial groups. For example, the mean duration of the first mirror-tracing task in the current study was substantially higher than the mean in studies of predominantly Caucasian smokers (Brandon et al., 2003; Cameron et al., 2013), though comparable to studies of predominantly African-American smokers (MacPherson et al., 2008). African-Americans also report feeling more confident in their ability to cope with emotional distress than other racial groups (Luberto, Cotton, McLeish, Mingione, & O’Bryan, 2012). Thus, the current sample may have had relatively high levels of baseline behavioral distress tolerance and, therefore, been less likely to benefit from the mindfulness training (Hsu et al., 2013).

**Smoking Urges**

The current results also did not support the use of brief mindfulness training for reducing cigarette cravings. These findings are in contrast to those of previous studies showing that mindfulness training reduces smoking urges (Cropley et al., 2007; Davis et al., 2014). However,
they are consistent with the distress tolerance findings in the current study. That is, the urge to smoke in response to a distressing task can itself be considered a reflection of distress tolerance to the extent that it reflects urges alleviate distress. Given that distress tolerance did not improve, but actually decreased over the current study, it is reasonable to expect that smoking urges would similarly not improve.

**Limitations and Future Directions**

Limitations to the current study should be noted. First, given that the majority of participants were African-American, the current findings may not generalize to other demographic groups. Future research should investigate racial differences in levels of distress tolerance, and whether distress tolerance is differentially related to smoking outcomes across racial groups. Second, the self-report measures were administered following the laboratory tasks, which could have influenced responding to questionnaire items (e.g., over-endorsement of pathology due to heightened negative affect in the moment). Third, as mentioned above, the behavioral distress tolerance tasks used in the current study may have limited ecological validity. If these measures do not provide an accurate assessment of smokers’ experiences in tolerating distress, the ability to examine how mindfulness impacts distress tolerance is impaired. Examining changes in distress tolerance throughout mindfulness-based smoking cessation interventions, or developing and examining smoking-specific behavioral distress tolerance tasks, might improve distress tolerance and smoking research.

**Conclusions**

Nonetheless, important conclusions can still be drawn. Based on the current findings, brief, single-session mindfulness exercises should not be expected to produce immediate improvements in distress tolerance or smoking urges, though they might reasonably be used to reduce current moment levels of distress and induce states of mindfulness in smokers. More frequent and repeated practice might be needed to improve smokers’ ability to withstand distress. The current findings also highlight the importance of considering the ecological validity
of behavioral distress tolerance tasks, and suggest that administering the same standard task within a single session might not be an optimal approach for measuring improvements in distress tolerance in smokers. Future studies should examine mindfulness and distress tolerance in smokers in the context of mindfulness-based smoking cessation interventions, or through the use of smoking-specific behavioral distress tolerance tasks. Further research on racial differences in distress tolerance may also be warranted.
References


RCT of a distress tolerance treatment for individuals with substance use disorders. *Drug and Alcohol Dependence, 122*, 70-76.


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Centers for Disease Control and Prevention (2009). History of the surgeon general’s reports on smoking and health. Office on Smoking and Health, National Center for Chronic Disease Prevention and Health Promotion [accessed 2013 June 20]


the five-facet mindfulness questionnaire to understand its relation to substance use. 

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lifetime smokers ages 25 to 44 years. *Cancer Epidemiology, Biomarkers, & Prevention, 17*, 1640.


validation of the Self-Other Four Immeasurables (SOFI) scale based on Buddhist teachings on loving kindness, compassion, joy, and equanimity. Social Indicators Research, 92(1), 169-181.


Thompson, B. L., & Waltz, J. (2007). Everyday mindfulness and mindfulness meditation:
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Table 1. *Baseline Demographic and Clinical Characteristics*

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<td>31 (73.8%)</td>
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<td>Caucasian</td>
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*Note.* There were no significant differences between groups on any variable. CPD: cigarettes per day; DTS: Distress Tolerance Scale (Simons & Gaher, 2005); AUDIT: Alcohol Use Disorders Identification Test (Babor et al., 1992). FTND: Fagerström Test for Nicotine Dependence (Heatherton et al., 1991).
### Table 2. Zero-order Correlations among Study Variables

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*p < .05, **p < .01
Note. DTS-1: Distress Tolerance Scale (Simons & Gaher, 2005) at Time 1; DTS-2: Distress Tolerance Scale (Simons & Gaher, 2005) at Time 2; HV-1: hyperventilation task at Time 1; HV-2: hyperventilation task at Time 2; MT-1: mirror-tracing task at Time 1; MT-2: mirror-tracing task at Time 2; QSU-MT-1: Questionnaire of Smoking Urges (Cox et al., 2001) following the mirror-tracing task at Time 1; QSU-MT-2: Questionnaire of Smoking Urges (Cox et al., 2001) following the mirror-tracing task at Time 2; QSU-HV-1: Questionnaire of Smoking Urges (Cox et al., 2001) following the hyperventilation task at Time 1; QSU-HV-2: Questionnaire of Smoking Urges (Cox et al., 2001) following the hyperventilation task at Time 2; SMS-1: State Mindfulness Scale (Tanay & Bernstein, 2013) at Time 1; SMS-2: State Mindfulness Scale (Tanay & Bernstein, 2013) at Time 2.
Table 3. *Descriptive Statistics for Outcome Variables by Group and Time*

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<th>Trial 1 [M (SD)]</th>
<th>Trial 2 [M (SD)]</th>
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<tr>
<td><strong>MTPT-C</strong></td>
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<tr>
<td>Mindfulness</td>
<td>245.6 (202.5)</td>
<td>198.0 (189.9)</td>
</tr>
<tr>
<td>Control</td>
<td>240.0 (218.0)</td>
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<td><strong>DTS</strong></td>
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<td>Mindfulness</td>
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<td>3.18 (0.89)</td>
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<td><strong>QSU-Brief</strong></td>
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<td>597.8 (334.3)</td>
<td>620.4 (338.6)</td>
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<td>Control</td>
<td>566.1 (296.8)</td>
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<td><strong>SUDS</strong></td>
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<tr>
<td>Mindfulness</td>
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<tr>
<td>Control</td>
<td>67.59 (13.90)</td>
<td>66.82 (15.16)</td>
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*Note.* MTPT-C: Mirror-tracing Persistence Task-Computerized; DTS: Distress Tolerance Scale (Simons & Gaher, 2005); QSU-Brief: Questionnaire of Smoking Urge- Brief (Cox et al., 2001); SUDS: Subjective Units of Distress Scale (Wolpe, 1969); SMS: State Mindfulness Scale (Tanay & Bernstein, 2013).
### Table 4. Analysis of Variance Results

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*p < .05.

*Note. Error$_W$ = error term for the within-subjects variable (i.e., time), Error$_B$ = error term for the between-subjects variable (i.e., group). MS = Mean Square; $\eta^2_p$ = partial eta squared. MTPT-C: Mirror-tracing Persistence Task-Computerized; DTS: Distress Tolerance Scale (Simons & Gaher, 2005); QSU-Brief: Questionnaire of Smoking Urge-Brief (Cox et al., 2001); SUDS: Subjective Units of Distress Scale (Wolpe, 1969); SMS: State Mindfulness Scale (Tanay & Bernstein, 2013).
Figure 1. Flowchart of experimental design. Participants provided SUDS ratings before and after each MTPT-C trial, hyperventilation trial, and mindfulness exercise/control condition. Participants completed the DTS and SMS before and after the mindfulness exercise/control condition.
Figure 2. Mirror-tracing duration as a function of group and time.
Figure 3. Self-reported distress tolerance as a function of group and time.
Figure 4. Smoking urges following mirror-tracing as a function of group and time.
Figure 5. Subjective levels of distress as a function of group and time
Figure 6. State mindfulness as a function of group and time.
Appendix A

Mindfulness Condition Script

For the next several minutes, I am going to ask you to engage in a practice called mindfulness. Mindfulness is a particular way of paying attention to our experiences: it means noticing whatever internal or external events are occurring right now, in the present moment, without judging those experiences or trying to change them in any way. These experiences can include our thoughts or emotions, sounds in the environment, or physical sensations in our body.

Mindfulness is often very different from how we usually live: oftentimes, we are thinking about things in the past, worrying about things in the future, or making comparisons or judgments between things. These tendencies are certainly helpful in allowing us to plan for things and make adaptive decisions; but, if we live this way all the time, we often miss the things that are right in front of us. For example, when you’re spending time with friends but keep thinking about a difficult exam you took earlier that day, you might be connecting with your friends less, or missing out on the conversation in some ways.

Mindfulness teaches us to regulate our attention to keep our minds focused on the present moment, whenever we choose to do so. This means noticing that our mind has wandered off from the present moment, and gently bringing it back to whatever experiences are happening right now, as best we can. Since our minds tend to wander so much, we just bring our minds back each time it wanders – if it wanders 100 times, that’s ok, we just bring it back 100 times. Mindfulness also teaches us to experience our thoughts and emotions with openness, curiosity, and acceptance, which helps us relate to them in a different way; specifically, we start to learn that we can let these events occur, even if they are unpleasant, because they will simply rise and fall naturally on their own – without us having to struggle to try to change them.
Training our attention to focus on the present moment, and learning to experience difficult thoughts or emotions without judging them or trying to change them, can be very hard at first. The best way to learn mindfulness is to practice, so let’s do that now.

To begin, go ahead and get comfortable in your chair, with both feet flat on the floor and your hands and arms resting naturally at your sides. If you feel comfortable, go ahead and close your eyes. If not, just let your gaze rest down at the floor a few feet in front of you. Remind yourself that in this moment, right now, there is nowhere else you have to be, and nothing else you have to do. Just settle into this moment, seeing if you can get a sense of yourself in this place and in this time.... Now, bring your attention to your breathing, and just notice the sensations of your breath...see if you can notice the way the air feels as it moves through your body...maybe you notice your abdomen rising and falling with each breath...maybe you can feel the breath in your throat or in your nose...just feel your breath... If you notice that certain thoughts are pulling your attention, celebrate that you’ve noticed that – that, too, is mindfulness – and gently bring your attention back to feeling the sensations of your breath, as best you can. *Wait 5-10 seconds*

Now, scan your body for any other physical sensations. You can start at the bottom of your feet and move up to the top of your head, just noticing the physical sensations that are occurring right now in different parts of your body... maybe you notice sensations of warmth or coolness... tightness or pressure... restlessness or numbness... just see what you notice, and observe what those sensations feel like. Maybe you also notice emotions – anxiety, sadness, contentment, or something else – as best you can, let those feelings occur without judgment, without trying to change them, and see what you notice about them. See what happens, if anything, when you let the emotion be as it is. Continue to scan your body for any physical sensations for just...
another moment or two… *(Wait 5-10 seconds)*

Now focus your awareness on any sounds in the room. See if you can notice the quality of these sounds, rather than labeling or judging them. Just let the sounds come to your ears. See if you can notice things like the pitch of the sound… the volume… the tone… just see what sounds you notice. When you notice thoughts or judgments, again, that’s ok – just gently bring your attention back to hearing the sounds in the room. *(Wait 5-10 seconds)*

Finally, shift your attention to your own thoughts. See if you can notice the thoughts that are occurring right now in your mind. Maybe you are thinking “this is stupid,” or “I hope this is over soon”… maybe you are thinking about what you are going to eat for dinner… or what you are going to say to a friend… just notice whatever thoughts you are having and, as best you can, allow the thoughts to come and go without trying to change them or trying to think about something else. *(Wait 5-10 seconds)*

Now go ahead and bring your attention back to feeling your breath again, for just a few more moments. Notice the physical sensations in your body as you inhale and exhale… just observing whatever sensations are there… for just a few more moments… and when you feel ready, go ahead and open your eyes… and release this practice.
Appendix B

Control Condition Script

Have you ever heard something described as rock solid? We usually use the phrase to describe something that does not and cannot change. It also means something’s absolutely sure and will not fail or go wrong. If we say a plan is rock solid that means the plan is a sure bet. It cannot change and it will not go wrong. The truth is, however, that rocks do change.

All rocks on earth change as a result of natural processes that take place all the time. These changes usually happen very slowly. They may even happen below earth’s surface so that we do not notice the changes. The physical and chemical properties of rocks are constantly changing in a natural never-ending cycle called the rock cycle. The rock cycle describes how each of the main types of rocks is formed, and explains how rocks change within the cycle. This recording will discuss the characteristics of rocks, how rocks are classified, and the details of the rock cycle.

A rock is a naturally formed non-living earth material. Rocks are made of collections of mineral grains that are held together in a firm, solid mass. The individual mineral grains that make up a rock may be so tiny that you can only see them with a microscope, or they may be as big as your fingernail. A rock may be made of grains of all one mineral type or it may be made of a mixture of different minerals. Most rocks contain more than one mineral.

Each rock has a unique set of minerals that make it up, and rocks are usually identified by the minerals observed in them. Since different minerals form under different environmental conditions, the minerals in a rock contain clues about the conditions, like temperatures that were present when the rock formed. Rocks can also be described by their texture, which is a description of the size, shape, and arrangement of the mineral grains. Rocks may be small pebbles, less than a centimeter, or they may be massive...
boulders that are meters wide. Smaller rocks form when larger rocks are broken apart and worn down.

Rocks are classified according to how they were formed. The three main kinds of rocks are igneous rocks, sedimentary rocks, and metamorphic rocks. Igneous rocks are formed when magnum, molten rock inside of the earth, or lava, molten rock that erupted onto the surface of earth, cools at or below the earth’s surface. Igneous rocks make up most of the rocks on earth. Most igneous rock is buried below the surface and covered with sedimentary rock, and so we do not often see just how much igneous rock there is on earth. One of the most common igneous rocks is granite. Granite is used extensively in building materials and making statues. Pumice is another example of an igneous rock. Pumice is used to make stone-washed denim jeans. Pumice stones are put into giant washing machines with newly-manufactured jeans and tumbled around to give jeans that distinctive “stone-washed” look. Ground pumice is sometimes added to toothpaste to act as an abrasive material that scrubs your teeth clean.

Sedimentary rocks are formed by the compaction of sediments, like gravel, sand, silt, or clay. Sediments may also include fragments of other rocks that have been worn down into small pieces; materials made by a living organism, or organic materials; or chemical precipitates, which are the solid materials left behind after a liquid evaporates. For example, if a glass of salt water is left in the sun, the water will eventually evaporate, but the salt crystals will remain behind as precipitants in the bottom of the glass. Most sediments settle out of water. For example, running water in rivers carries huge amounts of sediments. the river dumps these sediments along its banks and at the end of its course. when sediments settle out of water, they form horizontal layers. one layer at a time is put down. each new layer forms on top of the laers that were alredady there. thus, each layer in a sedimentary rock is younger than the layer under it and odler than the layer over it. when the sediments harden, the layers are preserved in large outcrops.
of sedimentary rocks, you can often see layers that show the position and order in which the original sediment layers were deposited. Scientists can figure out the relative ages of layers by knowing that older ones are on the bottom and younger ones are on top.

Lithification is the hardening of layers of loose sediment into rock. Lithification is made up of two processes: cementation and compaction. Cementation occurs when substances crystallize or fill in the spaces between the loose particles of sediment. Compaction occurs when sediments are squeezed together by the weight of layers on top of them.

Metamorphic rocks form when an existing rock of any type is changed by heat or pressure within the earth so that the minerals undergo some kind of change. Rocks can be changed from one type to another, and the rock cycle describes how this happens. For example, igneous rock may break down into small pieces of sediment and become sedimentary rock, or it may be buried within the earth and become metamorphic rock, or it may change back into molten material and re-cool into a new igneous rock. Thus, metamorphic rocks start off as igneous, sedimentary, or other metamorphic rocks. One way rocks may change during metamorphism is by rearrangement of their mineral crystals. when heat and pressure change the environment of a rock, the crystals may respond by rearranging their structure. they will form new minerals that are more stable in the new environment. extreme pressure may also lead to the formation of foliation, or flat layers in rocks that form as the rocks are squeezed by pressure. foliation normally forms when pressure was exerted on a rock from one direction. if pressure is exerted from all directions, then the rock usually does not show foliation.

Any type of rock can undergo changes and become any new type of rock. Several processes are involved in the rock cycle that makes this possible. Key processes of the rock cycle are: crystallization, erosion, sedimentation, and metamorphism. Crystallization occurs when molten material hardens into rock. An
existing rock maybe buried deep within the earth, melt into magma, and then crystallize into an igneous rock. The rock may then be brought to the earth's surface by natural movements. Crystallization can occur either under ground when magma cools or on the earth's surface when lava hardens. Pieces of rock at the earth's surface are constantly worn down into smaller and smaller pieces. The impacts of running water, gravity, ice, plants, and animals all act to wear down rocks over time. The small fragments of rocks produced are called sediments. Running water and wind transport these sediments from one place to another. They are eventually deposited or dropped somewhere. This process is called erosion, and sedimentation. The accumulated sediment may become compacted and cemented together into a sedimentary rock. This whole process of eroding rocks, transporting and depositing them, and forming a sedimentary rock can take hundreds or thousands of years. Sometimes an existing rock is exposed to extreme heat and pressure deep within the earth. Metamorphism happens if the rock does not completely melt but still changes as a result of the extreme heat and pressure. A metamorphic rock may have new minerals composition and/or texture.

The rock cycle really has no beginning and no end; therefore it is a never-ending cycle.